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نموذج رقم (١٨)
اقرار والتزام بالمعايير الأخلاقية والأمانة العلمية
وقوانين الجامعة الأردنية وأنظمتها وتعليماتها
لطلبة الماجستير

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عنوان الرسالة: ....
Distribution of Residential internal water use in Jordan: Al-Salt case study.

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DISTRIBUTION OF RESIDENTIAL INTERNAL WATER USE IN JORDAN :

Al-SALT CASE STUDY

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This Thesis was Submitted in Partial Fulfillment of the Requirements for the Master's Degree of Science in Water and Environmental Engineering/Civil Engineering

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COMMITTEE DECISION

This Thesis (Distribution Of Residential Internal Water Use In Jordan: Al-Salt Case Study) was successfully Defended and Approved on 28/4/2011

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I gift my thesis to my father God bless him

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LIST OF SYMBOLS AND ABBREVIATIONS

N	sample size
N	the community size
P	percentage of characteristic
D	Error percentage
Z	standard degree
S_1	variance of sample one
S_2	variance of sample two
n_1	sample 1 size
n_2	sample 2 size
V	degree of freedom
X_1	sample 1 mean of per capita daily water consumption
X_2	sample 2 mean of per capita daily water consumption
μ_1	population 1 mean of per capita daily water consumption
μ_2	population 2 mean of per capita daily water consumption
WAJ	Jordanian Water Authority
MWI	Ministry of Water
WEPIA	Water Efficiency and Public Information for Action
Lpf	liter per flush
Lpcd	liter per capita day
Lpm	liter per minute
KWh	Kilo Watt hour

DISTRIBUTION OF RESIDENTIAL INTERNAL WATER USE IN JORDAN: Al-SALT CASE STUDY

By
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Supervisor
Dr .Ahmad I. Jamrah, Prof.

ABSTRACT

Residential water uses were very important because of many environmental conditions such as global warming, and growing of population. Knowing the residential water uses help the researcher to choose the way of minimizing the water consumption and suitable way of water reuse

A questionnaire in the form of a social survey was designed and administered in the Al-Salt city were 132 samples formed out of 20 residential quarters in four different residential regions covered 688 householders to estimate the distribution of residential water uses in Al-Salt city and the amount of water and energy that can be saved if residents use water saving appliances, in addition gauging the public perception towards water saving appliances use. As result, the data collected were analyzed using statistical methods to examine variability, distribution, and statistical inference of the variables of interest.

Internal residential water was broken-down into different end uses where the average daily per capita water consumption was 103 Lpcd. Furthermore, the distribution usage of residential water use for an average household size of 5 persons was found ,where, 20.64% for sink use ,33.8% for shower,10.91%, for laundry , 4.1% for garden watering ,5% for cooking and 25.56% for black water.

In addition, hypothesis testing analysis was carried out and the null hypothesis was achieved where $\mu_1 = \mu_2$ of the daily water consumption, the result of the representative sample can be generalized on the entire city , where the mean of two samples of per capita daily water consumption not statistically significant at different confidence levels.

The overall water saving in survey was 23.1%. In other words, 5364.7 m^3 of water can be saved yearly which is equivalent to 5364.7 JD for 100% of representative sample who may use the water saving devices, that’s mean each family could save 41 m^3 /year as well as money, while 4791.2 m^3 /year could be saved for 89.31% who accepted the use of water saving devices, where 39 m^3 /year could be saved for each family. Moreover, 592267 m^3 /year could be saved for the 100% of the entire population of city who may use the water saving devices within 35 m^3 /year for each family. Also the overall energy money saving for each family of the representative sample varied between 17 to 89 JD a year according to their category of energy consumption.

The study recommended to use water saving devices because of the valuable amount of both energy and water that can be saved for the entire city which were estimated by the survey.

1. INTRODUCTION

Jordan is one of the poorest countries in the world with renewable fresh water resources. As a result, people should be directed and aware to efficient use of water resources, and reduce water consumption, where water deficit come as result of many environmental conditions in countries such as climatic changes, droughts, and limitations of fresh water resources and the growing of populations (Jorgensen et al., 2009).

Residential water use and consumption are the water which come from household faucets and taps that are used for drinking, cooking, bathing, washing clothes and other purposes, such as watering flowers and washing cars, also the habits of household member include information such as bathing frequency, laundry method and frequency, the amount of drinking water consumed, and any other uses, this is called a ‘‘Pattern and behavior of water use’’ (Zhang and Brown, 2005).

The distribution of water use within a residence varies from one country to another. For example, the distribution of domestic household water use in the United States includes 16.8% for showering, 1.7% for bathing, 21.8% for laundry, 26.8% for toilet flushing, 15.7% for faucet and sink, and 13.7% for leakage (Metcalf and Eddy, 2003). While the distribution of residential water use in Australia includes 33% for showering ,4% for bathing ,19% for laundry ,13% for toilet flushing ,17% for faucet ,1% for leak , 12% for irrigation and 1% for dishwasher (Willis et al., 2010).

Further more, measures should be taken to reduce interior water use and wastewater flow rates to conserve both resources and energy, also strategies for reduction of water consumption vary from restricting the use of certain appliances such as automatic dishwashers and kitchen food grinders, to installing water saving devices, in addition

knowledge of the distribution of internal domestic water use can help greatly in the proper use installation of water saving devices. For example, Metcalf and Eddy (2003) reports that while water saving devices achieve 16% reduction when used with showerheads, 50% when used with toilet flushing and 30% when used automatic laundry machines, no reduction in water consumption is achieved when these water saving devices are used with faucets and dishwashing equipment. Concluded that 29.89% will be saved of total daily water consumption per capita.

This research aims to determine the potential of saving in domestic water for both water and energy of Al-Salt city by find out the residential water distribution of water uses and handout the perceptions of households for using water saving devices.

In order to achieve the purposes of this research, a questionnaire in the form of a social survey were designed and administrated to an appropriate sample of households in the city of Al-Salt. The questionnaire was administered randomly, and tried to relate the internal domestic water use to variables such as class and category of residence area, type of dwelling, household income, family size along with age , household appliances, among others. The social survey also worked to come up with conclusions regarding the frequency of household internal water use (number of washing cycles per week, frequency of showering, frequency and type of sink use: hand washing, tooth brushing, ablution, and hair washing) and transformed it to daily water consumption per capita (Lpcd). The study also gauged the public perception towards possible strategies for reducing domestic water consumption such as the use of water saving devices

This thesis compromises six chapters. Chapter one includes an introduction to the research problem. Chapter two shows the water situation in Jordan and study area.

Chapter three reviews the literature of residential water uses , and water saving and. Methodology of analysis is explained in chapter four. Chapter five present the results and their discussions. Conclusions, and recommendations are provided in chapter six.

2. WATER SITUATION

2.1 Water situation in Jordan

Jordan is considered one of the poorest, countries of water resources in the world. As result, experts classify countries as water scarce if the threshold is below 1000m^3/year, in addition, according to world ranking of water insufficiency, Jordan is ranked as the tenth water insufficient country (Hadadin et al., 2010). In other words, Jordan's annual consumption is 1BCM/year which exceeded the annual renewable freshwater surface and groundwater supplies of 830x10^6/year that leads to a significant water shortage problem (Rosenberg et al., 2008).

Water is considered scarce when large number of people do not have safe and secure water source to meet their needs in significant period of time for that area, also, when supply falls below 1000 m^3 a country experiences water scarcity and when supply falls below 500 m^3 a country experience absolute water scarcity ,in addition Jordan is one of the countries who their renewable water resources threshold will become below 1500 m^3 in 2030 which were indicated in Table (1),also some countries entering the list after the year 2000 because of water deficit (Rijsberman, 2006).

Table 1. List of countries in Africa and Asia having renewable water resources below the calculated threshold 1500m^3/capita /year by the year 2030.

Afghanistan	Egypt	Kenya	**Niger**	**Tanzania**
Algeria	**Eritrea**	Korea Republic	**Nigeria**	**Togo**
Burkina Faso	**Ethiopia**	Lebanon	**Pakistan**	Tunisia
Burundi	**India**	Libya	Rwanda	**Uganda**
Cape Verde	**Iran**	**Malawi**	Saudi Arabia	Emirates
Comoros	Israel	Maldives	**Somalia**	Yemen
Cyprus	Jordan	Morocco	South Africa	Zimbabwe
Bold names are the countries entering the water deficit country list after the year 2000.				

Source: Rijsberman, 2006

Jordan's water resources are limited to cover the population demand in a sustainable supply because of arid and semi-arid climate, limitation of water resources, population

growth and economic development and the change in behavioral attitudes. Limitations refer to the fact that Jordan shares 40% of its resources with neighboring countries which control the most part of water supply. Furthermore, the forecasted per capita water supply will fall from the current 145m^3/yr to only 91 m^3/yr in the year 2025, if current water use continue in this trend (Hadadin et al., 2010). Table (2) shows that the water deficit in Jordan will increased through the next 30 years from 329 to 451 and 687 million cubic meters. Where Table (3) shows the decreasing of per capita water availability from 1955 to 2020 when the number of population is in continues increasing.

Table 2. Future water demand, supply, deficit in Jordan ($10^6 m^3$/yr).

Water criteria	2010	2020	2040
Total water demand	1383	1602	2236
Domestic	477	670	1263
Industrial	110	130	170
Irrigation	796	802	803
total water supply	1054	1152	1549
surface water supply	470	470	470
ground water	271	277	277
water deficit total	-329	-451	-687

Source: Hadadin et al., 2010.

Table 3. Population versus per capita water availability**.**

Year	total annual renewable fresh water available ($10^6 m^3$)	population (millions)	per capita water availability (m^3)	Source
1955	1331	1.447	920	Hadadin et al., 2010
1990	906	4.009	226	Hadadin et al., 2010
2010	750	6.1	145	MWI & Dpartment of Statistics, 2011
2020	1236	10.229	120	Hadadin et al., 2010

According to Department of Statistics Annual Report, the average daily per capita for Balqa'a is 155 lpcd in the year 2007. Figure (1) shows that Amman average per capita was slightly close to Balqa'a average daily per capita (Environmental Statistics, 2007).

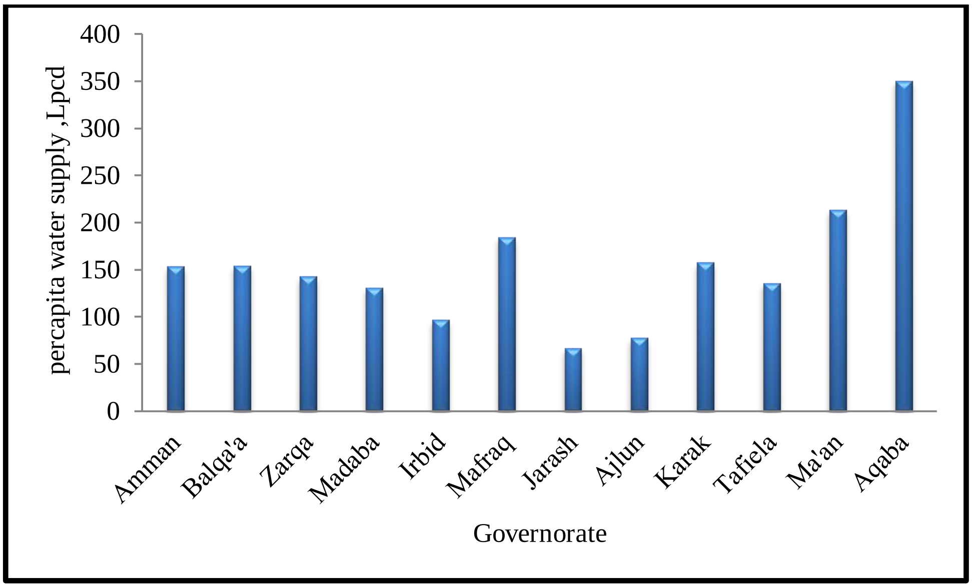


Figure 1. The average daily per capita water supply for all governorates in Jordan in the year 2007.

Source: MWI reported by Environmental statistics, 2007.

Per capita water supply for Jordan is changing from one year to another as shown in Table (4). The daily per capita water supply decreased from the year 2000 to 2002, and increased during the years from 2004 to 2007. Ministry of Water reported that the average daily per capita water supply for Jordanians is 145 Lpcd in the year 2010 (MWI, 2010). The water supply was varied from the year of 1997 to 2000 and then increased continuously till 2007 as shown in Figure (2), that’s mean the water demand increased through the years

Table 4. Per capita water supply in Jordan from 1997-2007.

Year	Per capita water supply(Lpcd)	Population number ×1000
1997	145.8	4506.0
1998	143.1	4623.0
1999	137.2	4738.0
2000	132.8	4857.0
2001	131.6	4978.0
2002	132.0	5098.0
2003	135.5	5230.0
2004	141.2	5350.0
2005	143.5	5473.0
2006	141.9	5600.0
2007	144.0	5723.0

Source: MWI reported by Environmental Statistics, 2007.

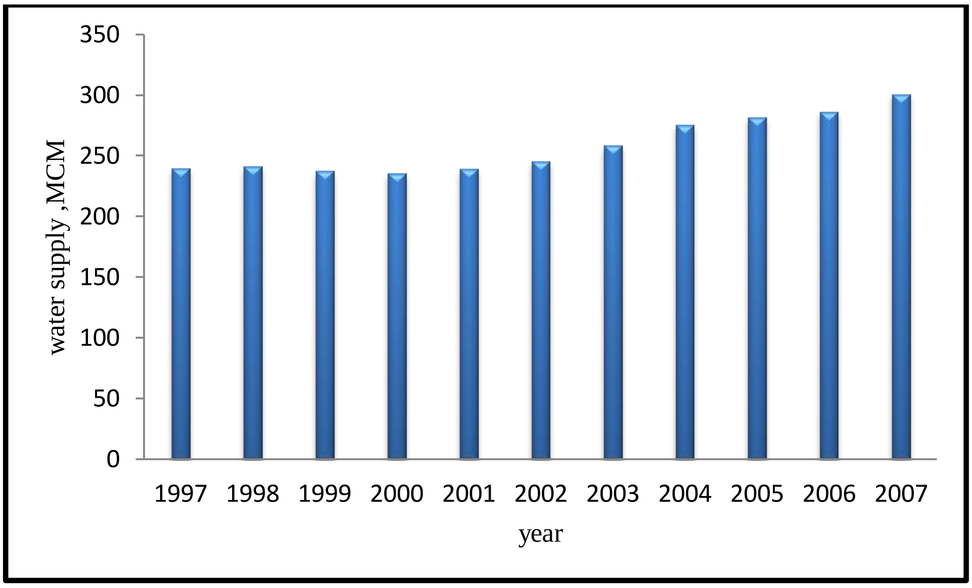


Figure 2. Water supply for all governorates from 1997-2007.

Source: MWI reported by Environmental Statistics, 2007.

The daily water consumption for Asia, Africa, and other countries is shown in Table (5), where developed countries are in similar ranges with world average daily per capita water consumption (Metcalf and Eddy, 2003).

Table 5. Per capita daily water consumption in different countries.

Country/area	Lpcd
China	80
Africa	15-35
Southeast Asia	30-70
Western pacific	30-90
Algeria, Morocco and Turkey	20-65
Latin America and Caribbean	70-190
World average	35-90
Eastern Mediterranean	40-85

Source: Metcalf and Eddy, 2003.

To diminish the water deficit in Jordan, people must be aware of how to use water in the right way, defining the water shortage problem, saving the sustainability of water by searching of new supplies of water, water harvesting, desalination and reuse of

wastewater in the agricultural sector and reduction of water demand (Hadadin et al., 2010).

2.2 Water situation in the study area

Al-Salt city is one of the Jordanian cites in the middle region of Jordan, and is sited in Balqa'a governorate, where Balqa'a area is 1119 km^2 (Governorate Indicators, 2007). Table (6) shows the population census for Al-Salt city in the year 2009, where Al-Salt has 20 residential quarters and 4 administrative regions with a population of 85034 person. (Department of Statistics, 2010).

Table 6.Population census for Al-Salt city, 2009.

Area	Region	Residential quarter	Female census	Male census	Total
Al-Salt city	First	Al-Qal'ah	3318	3669	6987
		Wadi-Al Halaby	1238	1333	2571
		Al-Maydan	1036	1181	2217
		Al-Jad'ah	1372	1578	2950
		Al-Mnshyah	1037	1056	2093
		Al-Aizaryh	1358	1369	2727
		Wadi-al'akrad	1144	1407	2551
	Second	Al-Safih	7548	7737	15285
		Sawada	3633	3782	7415
		Kuforhuda	260	296	556
		Al-Mussla	333	401	734
		Al-Salalim	9342	9713	19055
	Third	Al-Naqab	2325	2473	4798
		Al-Shafa	1857	1978	3835
		Al-Siroo	1109	1163	2272
	Fourth	Batna	552	594	1146
		Alqassam	142	152	294
		Om-Zaytoonih	218	238	456
		Al-Myameen	2984	3090	6074
		Al-mzwd	493	525	1018

Source: Department Of statistics, 2010.

A water supply for Balqa'a governorate in the years of 2008 and 2009 were 21,365,230 and 22,939,051 m^3; respectively. Where the supply in the year 2009 is greater than that in the year 2008 for about 3.37%. The per capita water supply for Balqa'a governorate

from the year 2003 to the year 2010 shown in Table (7), where the per capita supply hits the maximum in the year 2004 and hits the minimum in the year 2005.

Table 7. Per capita water supply for Balqa'a from 2003-2010.

Year	Per capita water supply;Lpcd
2003	137.9
2004	190
2005	128.3
2006	154.1
2007	157
2008	157
2009	157
2010	145

Source: MWI, 2010.

According to the Jordan Water Authority in Al-Salt city the number of subscribers for Balqa'a governorate are 62,747 while the number of subscribers for Al-Salt city are 25908, the subscribers not only residents but also commercial and industrial sectors (WAJ, 2011). Where Figure (3) shown the customer location and distribution in the year 2011, and Figure (4) shows Al-Salt city map.

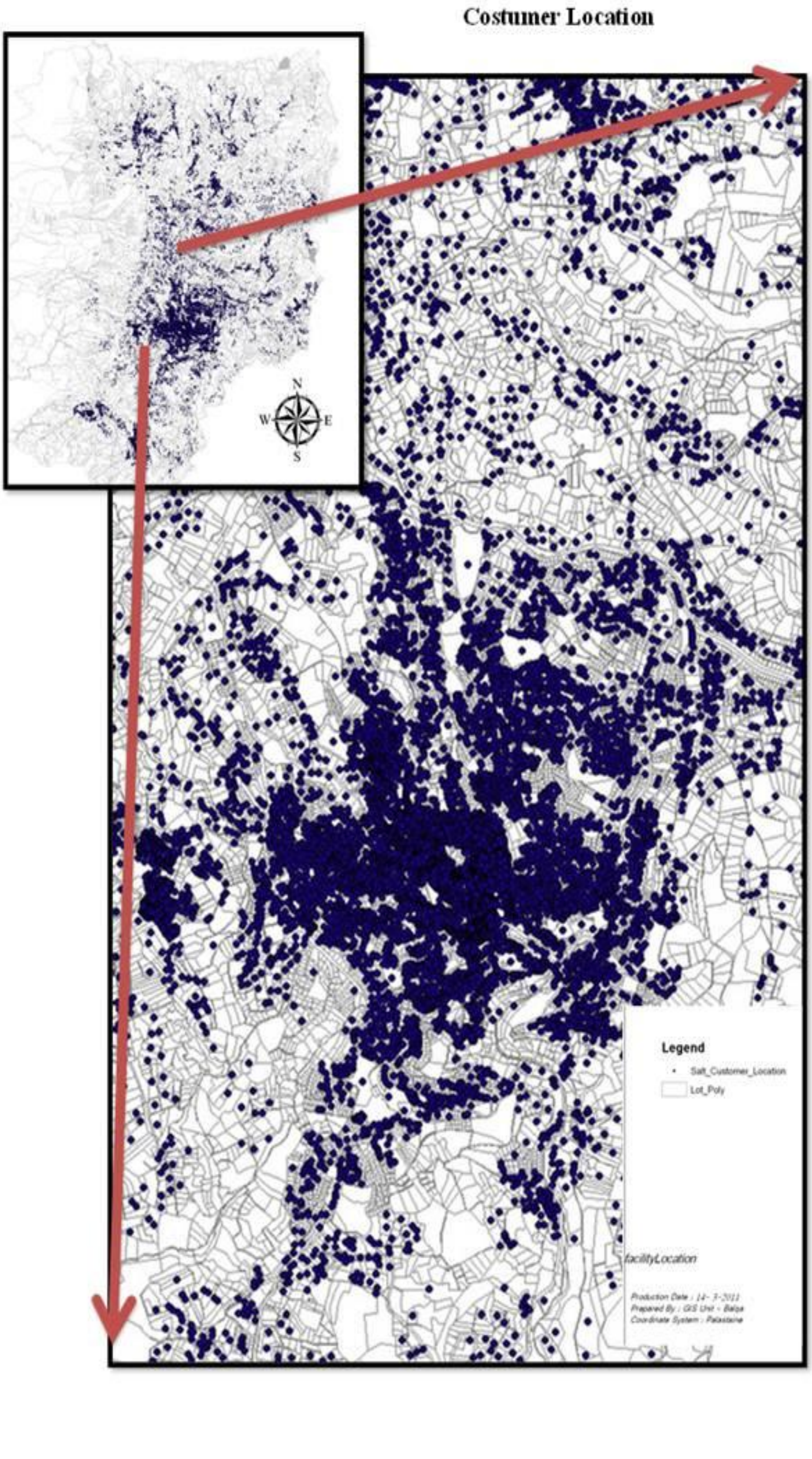


Figure 3. The water subscribers distribution and location in Al-Salt city in the year 2011.
Source: WAJ of Al-Salt city, 2011

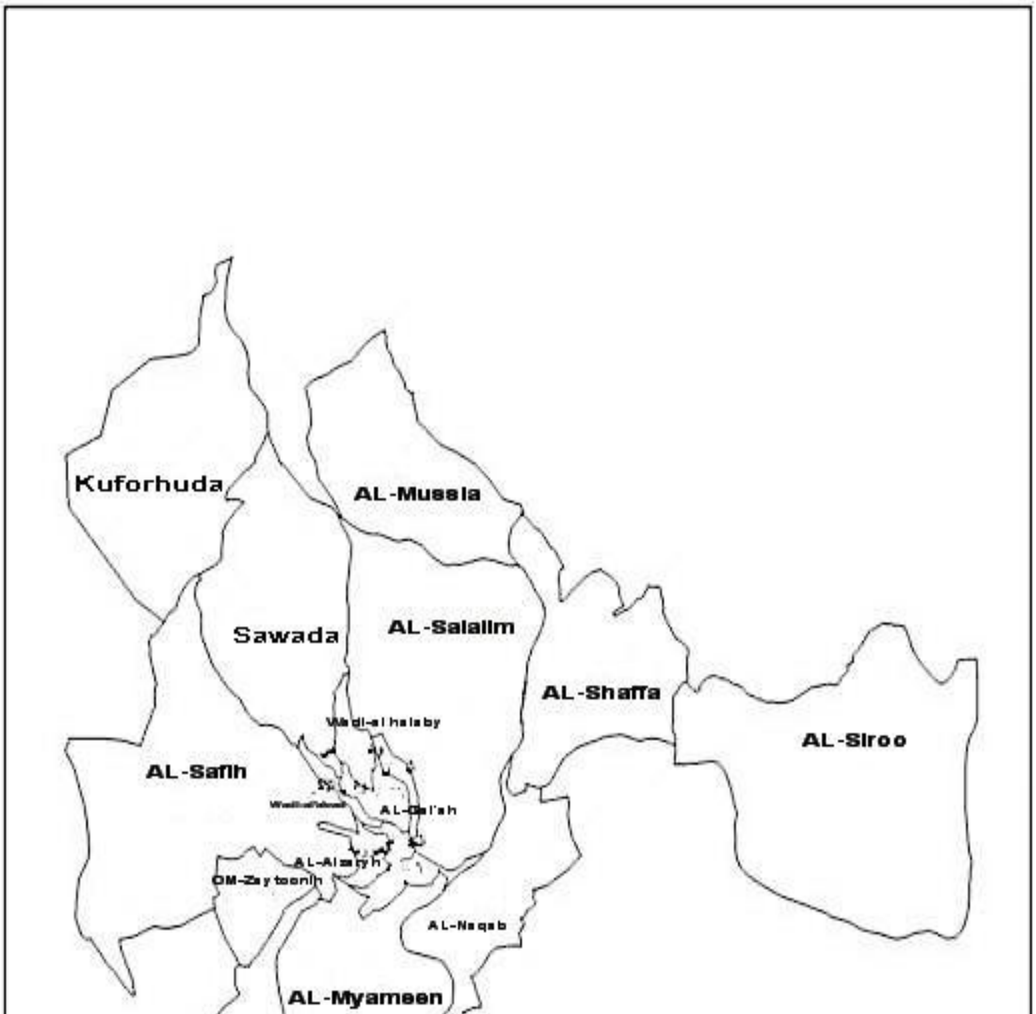


Figure 4. Al-Salt city residential quarters.
Source: Department Of Statistics, 2010.

3. LITREATURE REVIEW

This chapter presents some related studies and sheds the light on residential water use, end-use analysis and water saving criteria.

3.1 Residential water use and water saving

The researchers analyzed the residential water uses and the amount of water consumption in each use such as showering, bathing, laundry, toilet flushing, faucet and sink, leakage, garden watering and car washing according to statistical analysis or loggers and metering devices. The data were collected from many residence houses in different countries and cities, such as U.S.A, U.K, New zealand ,Jordan and many others. As result the researchers recommended and adopted water saving criteria when they had enough knowledge of the distribution of internal domestic water use.

Naserddin, (2009) Forecasted the distribution of internal domestic water using a device called data logger and sub metering devices where shown in Figure (5). This study was detected for three types of residential units (apartments, houses and villas) using 16 sample sites in different residential neighborhoods of Amman city with 6 persons average house hold size, the resulted average breakdown of the water usages by percent represented in Figure (6)

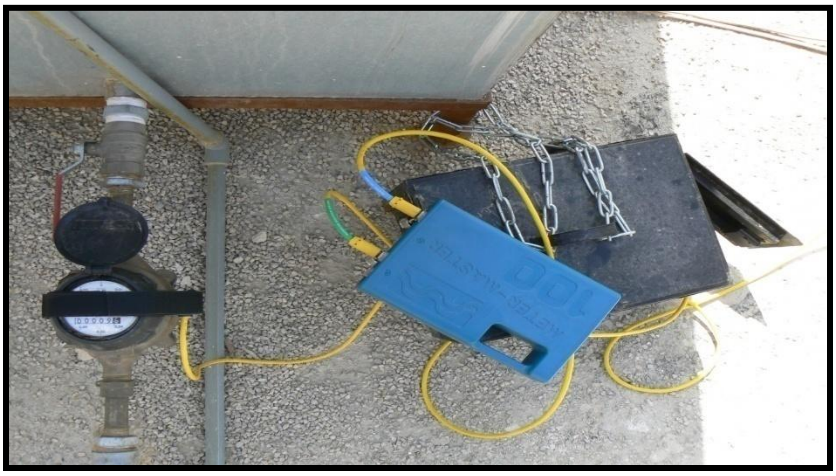


Figure 5. Data logger .
Source: Naserddin, 2009.

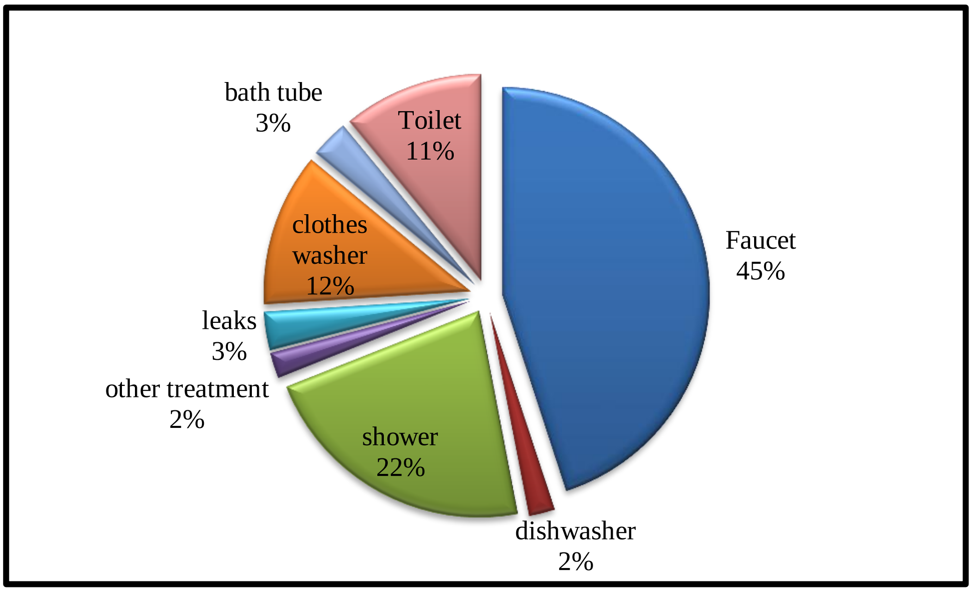


Figure 6. Average breakdown of the fixtures water usage by percent.
Source: Naserddin, 2009.

Naserddin, (2009) recommended to get an accurate input data by large representative sample for demand forecasting models.

Jamrah et al (2008) studied 38 areas of Amman that covered 233 houses and 1514 people. The frequencies of residential water use were examined, in addition to the potential of greywater availability and the components constituting sources of greywater generated in Amman. They also investigate the water quality parameters of greywater in order to assess its reuse potential and at measuring the public acceptance of greywater reuse for different applications, the distribution of residential water use in Amman is summarized in the Figure (7).

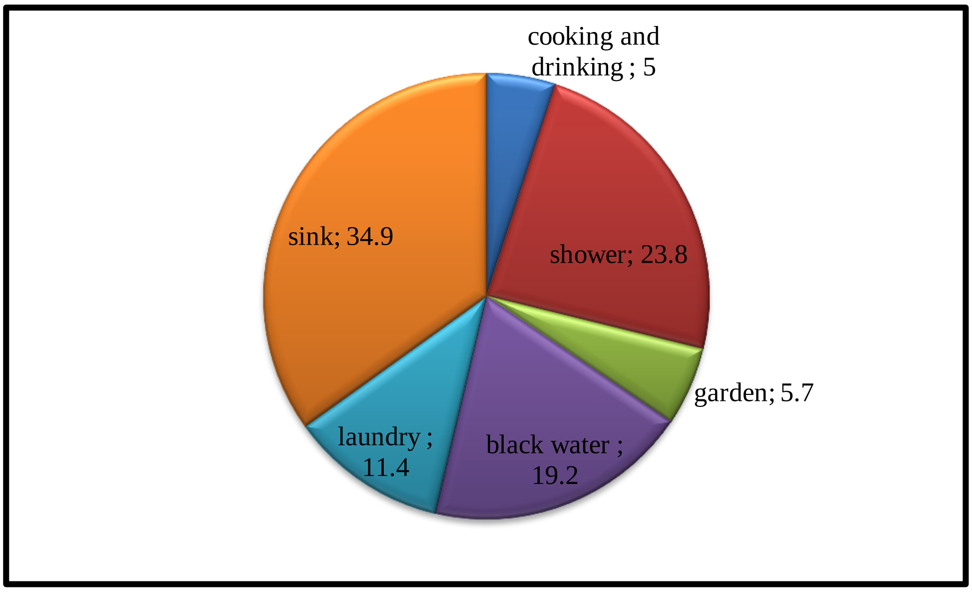


Figure 7. Percent use of residential water in Amman.
Source: Jamrah et al., 2008.

Jamrah et al. (2006) evaluated the internal domestic water distribution of Muscat governorate and the potential of greywater availability in Muscat Governorate in Oman and establish a methodology for greywater quantity estimation, and testing greywater quality in order to assess reuse potential, and to examine public acceptance for reuse. The study took place in 5 administrative areas, water meter were installed in 5 houses at sultan Qaboos university campus to estimate the water consumption and evaluates the amount of water usage for individual purpose like bath room, shower, sink, kitchen, washing machine and garden watering.

The consumption of water and energy in the University campus of Bordeaux were studied to high light the diversity of activities and end uses, the method of working depends on the evaluation of floor surface area-based ratios for each activity, where all institutions in campus considered. Also the relative share of major uses and the estimation of water conservation potential at the campus scale were studied, a recommendation to improve appliances carried out by adopting flow water saving appliances and using a Laser equipment (Bonnet et al., 2002)., Figure (8) shows the

campus institutions floor area, Figure (9) shows the water consumption in the campus institutions and Figure (10) shows the fixture of end uses of water for the whole campus.

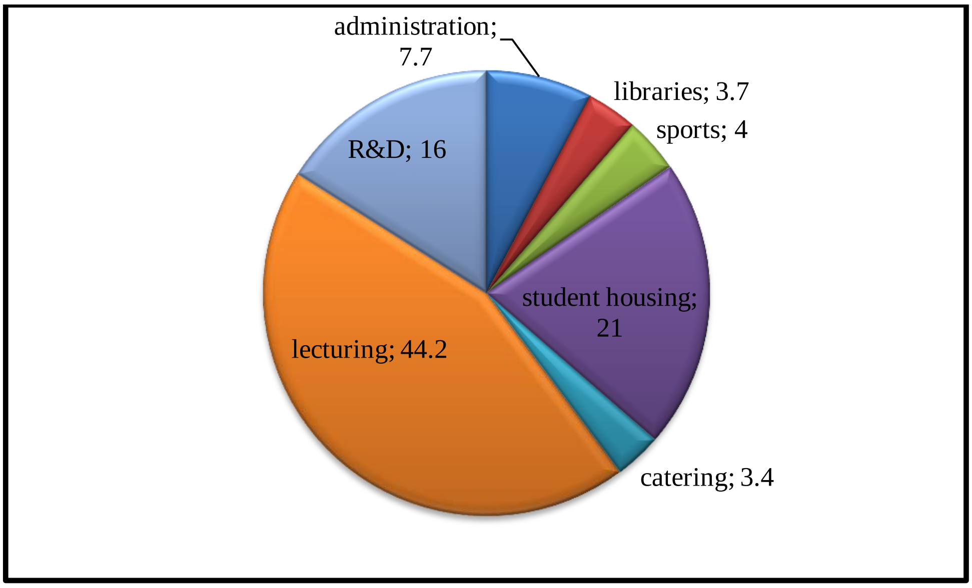


Figure 8. Percent fixture of floor area of the campus.
Source: Bonnet et al., 2002.

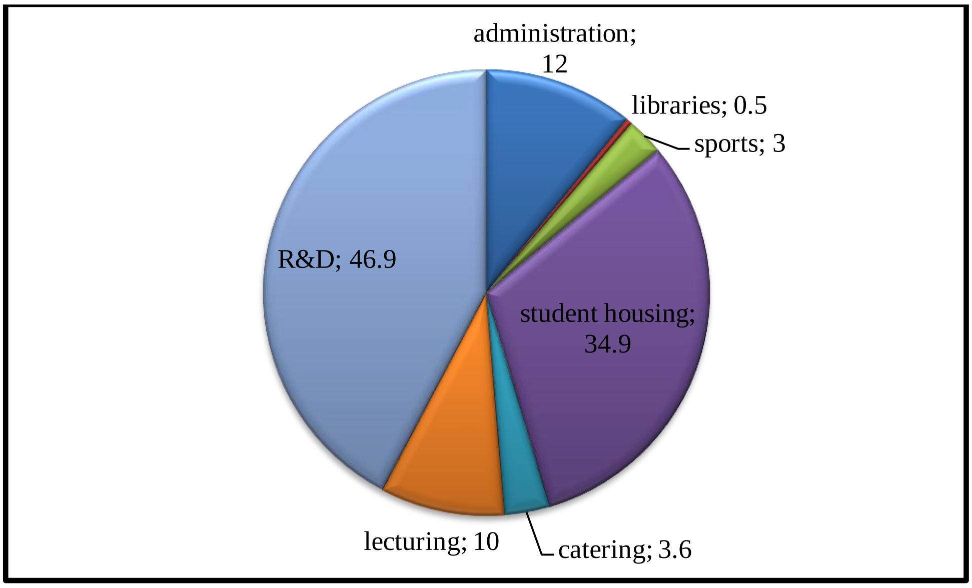


Figure 9. Percent of water consumption through the campus institutions.
Source: Bonnet et al., 2002.

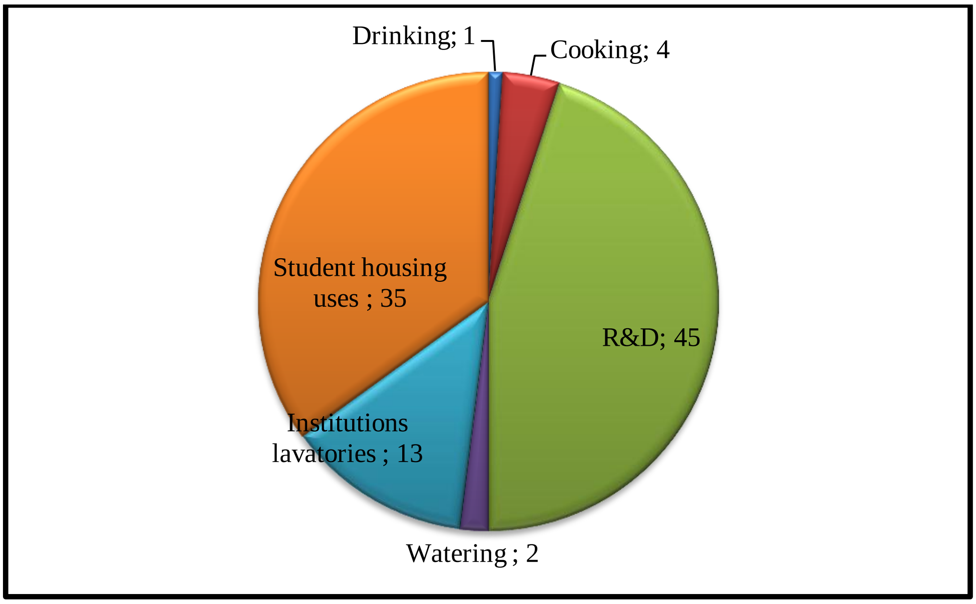
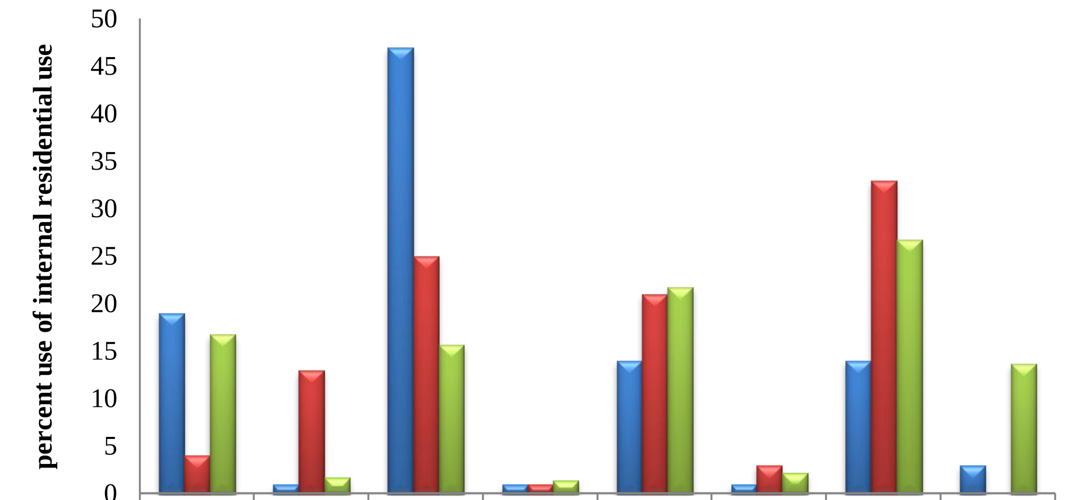


Figure 10. Percent aggregation of water consumption by end uses (sports excluded). Source: Bonnet et al., 2002 .

The distributions of internal residential water use studies have been adopted from many countries to take decisions in waste water management, water reuse and to overcome water crises. Figure (11) shows the distribution of internal residential water use in three countries, U.S.A, U.K, and Jordan, where Jordan hits the minimum usages in water for bath, dishwashing, clothes washing, other domestic and toilet flushing than U.S.A and U.K.



	shower,	Bath	Faucet	Dishwashing	clotheswashing	other domestic	toilet flushing	Leakage
JO	19	1	47	1	14	1	14	3
U.K	4	13	25	1	21	3	33	0
U.S.A	16.8	1.7	15.7	1.4	21.8	2.2	26.8	13.7

Figure 11. Comparison between the percent use of internal water for the different internal water uses in Jordan and other countries.
Source: (MWI, 2010, Burkhard et al., 2000, Metcalf and Eddy, 2003); respectively.

A survey was focused on the determinants of domestic water use in rural area of Benin, depends on households without access to private improved water sources, the determinants were analyzed in addition to water use behaviors as a function of water availability by explicitly estimating domestic water use for both rainy and dry seasons, they conclude that important determinants of water use are household size and composition, access to water sources, wealth and time required for analyzing water, Nevertheless, the effects of these determinants vary between household types and seasons (Arouna and Dabbert, 2010).

A survey of 653 rural house holds in 33 villages of Ramjerd area was carried out, using a simple random sample technique to study the factors that affects the consumption of domestic water. A relation between water consumption and rural area household activates were concluded. In addition, the water consumption affected by home size, age

of household heads, garden size, green house size and garden watering times per month (Keshavarzia et al., 2006).

Portnov et al. (2008) studied the water consumption in Israel from one sector to another and the reasons of increasing the water consumption which was differ widely in the domestic sector. The consumption of water rises and grow fast which indicates that the water consumption rates converge over time, rising standards of living in poor localities and the saturation of water consumption in remote places, also the development of infrastructure let the households consume more water and contribute in the convergence of water consumption rates for domestic use.

A new behavioral model is introduced as shown in Figure (12), to understanding residence water consumption influencing factors and the influence of trust on householders, researchers argue two concepts (inter personal trust and institutional trust), if trust plays a role in household water consumption, that means people will not save water if they feel others are not minimizing their water use, in addition they will not trust water authority (Jorgensen et al., 2009).

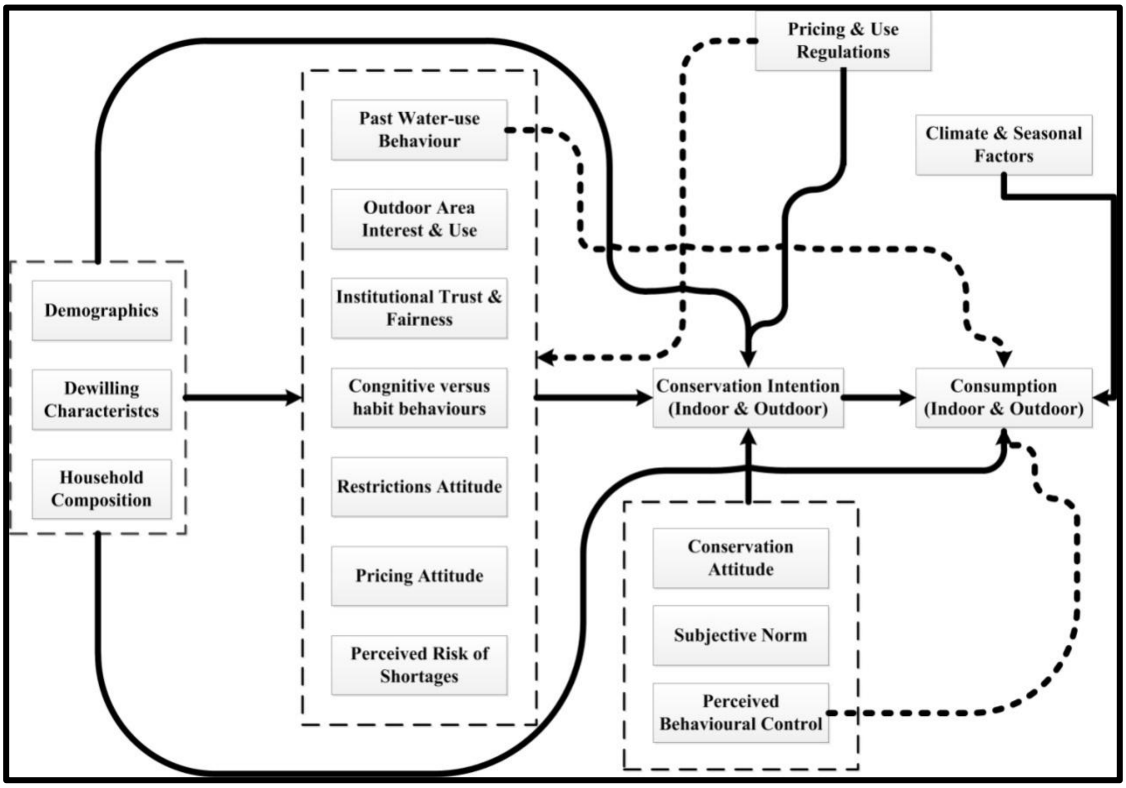


Figure 12. Integrated social and economic household water consumption model. Source: Jorgensen et al., 2009 .

An interview is conducted in ten office buildings located in Florianópolis, southern Brazil to estimate the water end uses, the data included the daily amount of time and frequency of use of water for toilet flushing, taps, cleaning and other uses, the distribution water use in each building shown in Figure (13). Water flow rates were measured for taps and bowl, and tank toilets, the water flow rate was obtained from a Brazilian Standard which suggests 1.7 L/s. the monthly water consumption in the buildings and the water end uses were calculated. The estimated water consumption in each building was compared with the measured consumptions supplied by the local water utility (considering the average consumption from September 2004, to August 2006). The consumptions were divided into four main specific consumption such as: toilet flushing, taps (water used in the lavatories for hands washing, teeth brushing, cleaning, and other uses (water used for making coffee, washing fruits, drinking and

other uses from kitchen tap), as result, toilet flushing is responsible for 52–84% of the total water consumption in the ten buildings. so they recommended when water conservation adopted it should be applied firstly on toilet flushing because of its high percentage consumption of total water supply in buildings (Proenc and Ghisi, 2009).

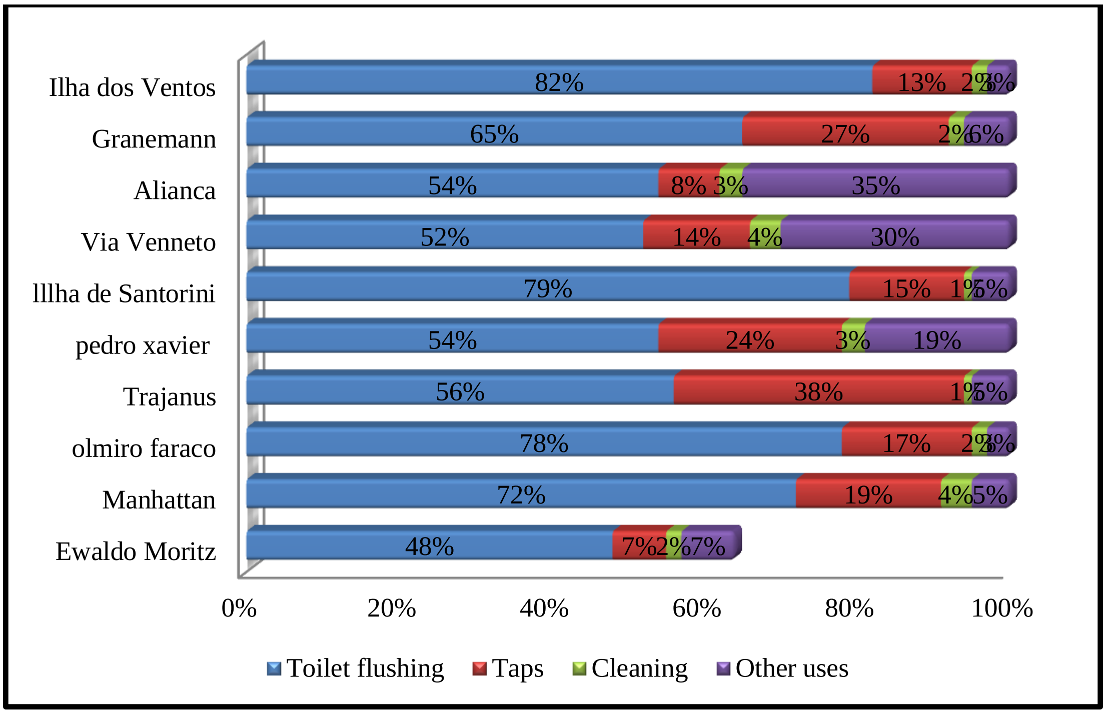


Figure 13. Potable water end-uses for the ten office buildings. Alianc, Ewaldo Moritz, Granemann, Ilha de Santorini, Ilha dos Ventos, Manhattan, Olmiro, Faraco, Pedro Xavier, Trajanus and Via Venneto.
Source: Proenc and Ghisi, 2009.

A survey study by New Zealand took place in Auckland through two seasonal periods, summer and winter to assess seasonal differences in residential water use. Water end use was monitored in 51 residential buildings in New Zealand. By using Flow profiles at 10 second intervals, data were collected with a BRANZ data logger. For each data record the individual end use would be identified using the Trace Wizard software calibrated for that specific dwelling, where Figure (14) and (15) shown the household consumption in both season, where the shower, washing machine and taps usages in

winter are increased while the other usages are decreased in compared to the summer season.

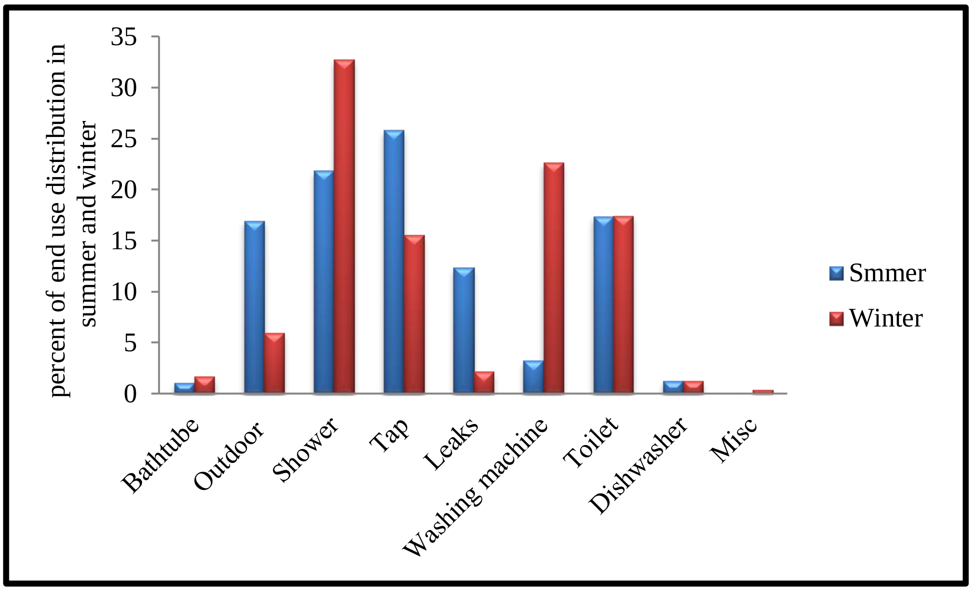


Figure 14. Percent of water end use distribution in summer and winter in Auckland.
Source:Newzealand,SB:10.

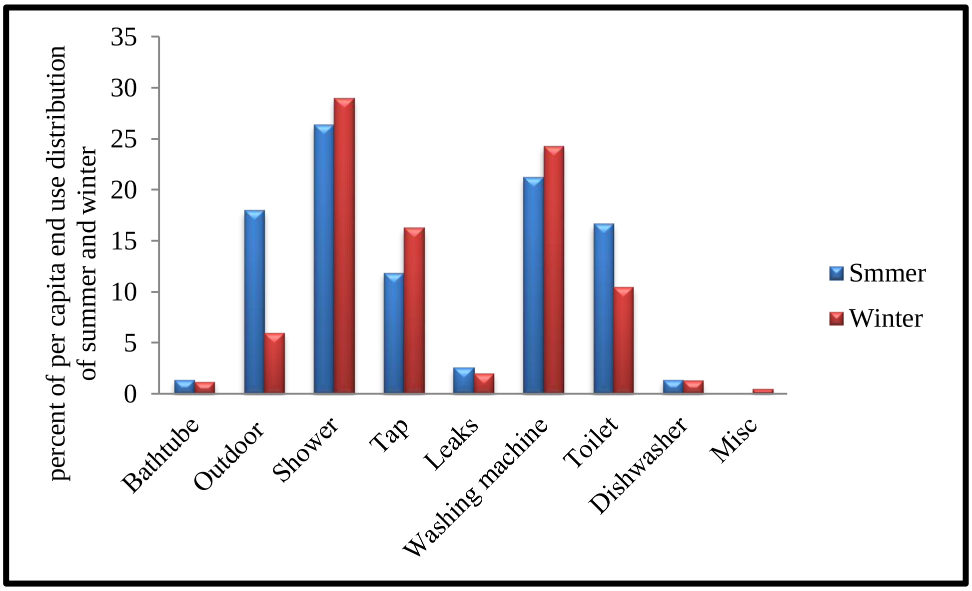


Figure 15. Percent of per capita water end use distribution in summer and winter in Auckland.
Source:Newzealand,SB:10 .

To overcome the dry climate challenges and variable rainfall in Australia, A study in Golden Coast of Australia measures the flow rates of end use events (e.g. shower, washing, machine and taps) and the potential of water savings for a sample of 151 Australian households Questionnaire with specified and unique information were distributed, so a high resolution metering data and loggers data were used to register and monitoring the consumption flow rates of end use events. Australian focus on daily per capita shower end use, the monitoring covered 44 households where an installation of an alarming visual display meters as shown in Figure (16) where locked at 40 L consumption based on 5 min shower at a flow rate of 8 L/min the sample before and after installation were converted to database and analyzed, where 15.4 L reduction of shower events volumes achieved by the choice for households of getting out of the shower when the beeping occurs , Figure (17) shows the distribution of water end uses for householders in Golden Coast of Australia (Willis et al., 2010).



Figure 16. The alarming visual display meter.
Source: Willis et al., 2010.

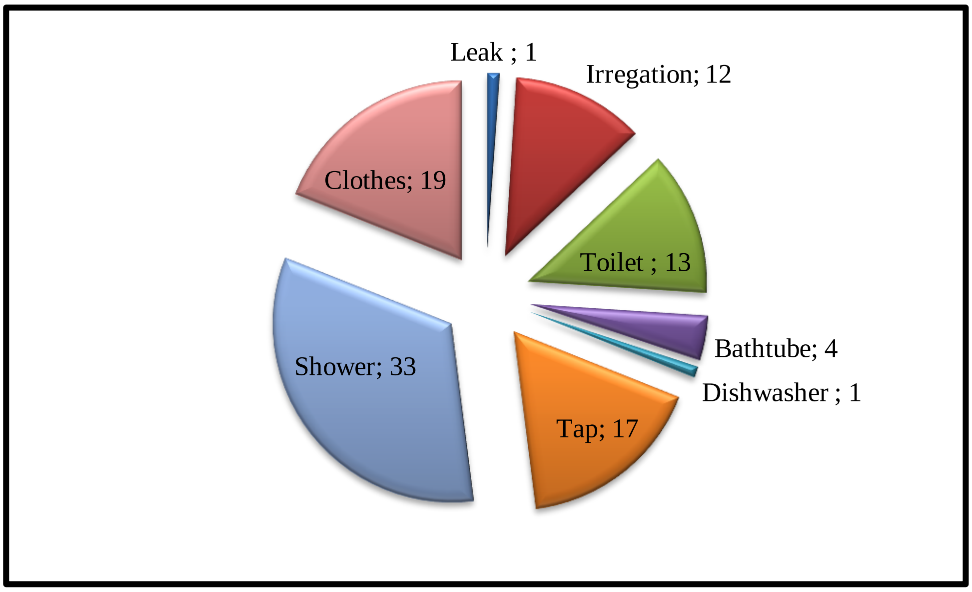


Figure 17. Percent of water end use distribution for Australian people in Golden Coast at winter 2008.
Source: Willis et al., 2010.

A telephone survey to study Sydney household's attitudes to water consumption and the ways in which domestic demand for water may be reduced, where the information was collected in a period when strong water use restrictions were in place and major arguments were being mounted in favor of water pricing as a way of moderating demand. The kinds of dwellings, the cultural, behavioral and institutional aspects of consumption, government water policies, and/or providing alternative domestic supplies of potable water are considerable factors in determining people demand for water, survey asked if they use water saving fittings, or if they adopt a certain practice to save water, they found that both the use of water saving devices and adoption of water use practices in the home were highly varied. While half of those surveyed said they had at least one water efficient shower head, only a third have reducer fittings on taps in the kitchen or bathroom and few have fitted in the laundry, also the survey obviously shown the attitudes and responses for water that can be saved by households awareness and behavior through the last 12 month and the expected behavior through the next 12 month (Randolph et al., 2008).

Seven water saving measures have been implemented in Korea to diminish the residential water demand, that includes water savings for toilets, faucets, and showers outdoor water use restrictions, an ordinance to regulate water waste, the repair of broken washers, and the replacement of leaking pipes. Water use can be greatly reduced by adopting water-efficient toilets, faucets, and shower heads (e.g. the traditional toilet consumes 13 L per flush, while a toilet designed to save water only uses 6 L per flush). In order to encourage the installation of water saving devices, incentives can be provided for users who adopt water savings measures, also all of the above seven water savings measures were implemented for the year 2018 and their effects on the water supply system were forecasted. 6.2% of total water demands were decreased in 2018 due to the water saving measures application (Chung, 2009).

A survey in Devon, UK is adopted to measuring the social attitudes and behaviors in saving water, and examining the relation between water saving and energy saving and waste management inside and outside home, a sample of 1265 households is covered and the researchers define different types of individual water saving behaviors upon their demographic composition and a range of attitudinal factor furthermore, they divided behaviors of water saving into three categories, first those who undertaken with most regularity, such as turning off the tap when cleaning teeth or washing the dishes and using a shower rather than a bath, without water saving activities, second, behaviors such as turning off the water whilst soaping up in the shower or reducing the amount of toilet flushes, third, behaviors with activities such as reducing the number of baths and showers, in order to examine the social and attitudinal characteristics that underlie alternative forms of water saving behavior (Gilg and Barr, 2006).

Data about the perception and attitudes toward water management and conservation were collected in Bulgaria. Researcher asked the households if they heard about water conservation by radio, television, newspaper, ministry of environment and neighbors. They describe low flow shower heads and toilets, and found that 43% never heard about it, and 6.6% of respondents using water saving toilets and 13.1%using water saving shower heads. People when they asked about why they didn't use the fixtures water saving in their homes the only predominant reason is a lack of finance. 80% of respondents show their willingness to replace the current toilet with a new water saving model if and only if several of neighbors and friends buy them. The study shows the desire for residential water users to know more information about water conservation (Clark and Finely, 2008).

There were two demand management actions that have been recommended for urban residential water users in Jordan to diminish water using and to face the determinant of water, long term demand and short term demand managements actions were proposed

Long term demand management actions defined by installing water saving devices such as faucet aerator in kitchen, bath faucets and shower heads, replace western toilet tanks larger than 7 L with smaller tanks, households can buy an efficient laundry machine which reduce 61% of water consumption of semi automatic machine and 20% for full automatic machine. Install house spray nozzle to reduce wastes while garden watering and using floor carpeting at homes to reduce indoor floor washing, short term demand management applied by installing bottles in toilet tanks to reduce flush volume, find and fixing leaks in piping system inside home (Rosenberga et al., 2008).

Several perspective appliances were used in Jordan according to the water efficiency and public information for action project (WEPIA), for saving water such as a plastic

bag which is shown in Figure (18), where put in the toilet tanks and filled of water to reduce the amount of water per flush, for intensive and efficient saving they recommended to change the toilet tanks to two flush stages, however, people need to change the appliances inside toilet tanks costing JD 18-20 (MWI, 2010).



Figure 18. Plastic bag .

In addition, faucet aerator used on the head of faucet or at faucet tube to reduce water consumed per use, it depends on mixing the water with air, the faucet aerator must be cleaned periodically every 3 months to remove calcinations by merging it in vinegar for 12 hours, furthermore, the price of faucet aerator is approximately JD 2.5-3 (MWI, 2010).

Moreover, two types of showerheads appliances were mentioned in WEPIA, one is put behind the showerhead cost about JD 3.5, another type is showerhead which has a valve open and close through showering, this type saves more water but it costs more between JD 8-10 (MWI, 2010). Figure (19) shows the low flow shower head.



Figure 19. Low flow showerhead.

4. METHODOLOGY

This study employs descriptive tools to achieve the research objective. Primary source data was used. Data samples were built through survey questionnaire 688 residential householders in Al-Salt city are included. We use several statistical tests to examine the research question. Following, we describe the steps of the analysis, study sample: selection and sizing, questionnaire preparation and distribution, criteria of water end use analysis, criteria of water and energy savings analysis.

4.1 Study Sample

4.1.1 Sample selection

A simple geographic distribution criterion is employed for selecting the target housing units. Al-Salt city is divided into four regions with twenty residential quarters, namely Al-Qal'a, Wadi-Al-Halaby, Al-Maydan, Al-Jad'ah, Al-Mnshyah, Al-Aizaryh, Wadi-al'akrad, Al-Safih, sawada, Kuforhuda, Al-Mussla, Al-Salalim, Al-Naqab, Al-shafa, Al-Siroo, Batna, Alqassam, Om-Zaytoonih, Al-Myameen and Al-Mzwd. Samples were formed randomly in a way to cover all residential quarters, through talking to friends, family relatives, and partners to get their approval to fill the questionnaire. Eventually, the questionnaire where covered all residential quarter.

4.1.2 Sample Size

To do a representative sample for Al-Salt city with 90% precision level an equation is used (Mountgomery and Runger, 2007) to determine the sample size depending on the number of population for Al-Salt city regarding to the accounting census of the year 2009 which is 85034 (Department Of Statistics, 2010).

$$n = \frac{N \times p\,(1-p)}{\{[N-1 \times (d^2 \div z^2)] + p(1-p)\}} \qquad (4.1)$$

n: sample size

N: population number (Al-Salt City Population which is 85034)

P: percentage of characteristic =0.5

d: Error percentage =0.1

z: standard degree of 0.9 which meet the value of 1.645

4.2 Questionnaire preparation and distribution

In order to achieve the purposes of this research, a questionnaire in the form of a social survey was designed and administrated to an appropriate sample of households in the city of Al-Salt.

The questionnaire was formed to cover the following aspects:

- Demographic, such as class and category of residence area, type of dwelling, house area.
- Social, such as household income, family size and age distribution.
- Behavioral, such as frequency of household internal water use, e.g., number of washing cycles per week and type of washing machine, frequency of showering, frequency of car washing, garden watering, and frequency and type of sink use (hand washing, tooth brushing, ablution, hair washing).
- Saving appliances, the questionnaire asked people about water saving appliances and gauging the public perception towards possible strategies for reducing domestic water consumption.

The questionnaires were handed over to the dwellings owners to fill it. Some people filled the questionnaire by themselves and the others asked for help in filling it. For that reason, the questions were designed in Arabic language from the first place to make sure that all householders can understand and answer the questions. Appendix (A) includes the Arabic version of the questionnaire and the translated version into English language.

4.3 Criterion of water end use analysis

The analysis of the end uses of water depends on the frequency of water end uses, in addition to the assumed values which shown in Table (8)**.**

Table 8. The assumed values for each interior use of water at home.

Assumptions	Values
Automatic washing machine	90 l/1use
Manual washing machine	60 l/ 1 use
Average water consumption in one shower	60 l/ 1 use
Average hand basin flow	6 l/ min
Volume of drinking and cooking	5% of total water consumption of residence (water bill)
Volume of garden irrigation	6% of total water consumption of residence (water bill)
Tooth brushing time	0.33 min
Ablution	2min
Hair washing	1min
Hand washing time	0.33 min
Neglecting leakage	0

Source: MWI, 2007, reported by (Jamrah and Ayyash , 2008)

The following components of household water use were calculated from the study:

Sink use: the total water used in sink is the daily water consumption of hand washing, hair washing, tooth brushing, and ablution.

The amount of water consume in Sink is the assumed flow rate l/min multiplied by the assumed time for each sink use and the number of uses.

Laundry use: is the amount of water consumed in clothes washing. The amount of water used in laundry depends on the type of clothes washer, manual or automatic. Hence, the volume of water assumed for manual washing machine is different than that for automatic washing machine.

The amount of water consumed in Laundry is the number of times washing machine multiplied by the volume of water assumed upon the type of clothes washer.

Shower use: is the amount of water consumed through showering. The daily amount of water consumption per capita depends on the frequency of showering weekly and the family size.

Cooking and drinking water use: Amount of water consumed for cooking and drinking is of 5 % assumed of total water consumption of residence (water bill).

Garden watering use: Amount of water consumed for garden watering is of 6% assumed of total water consumed of residence (water bill).

Total amount of water consumed in residence homes: The questionnaire asked people about their quarter bell amount or the cubic meter consumed per quarter. The total volume of water consumption of each residence by the help of consumer's directory of Ministry of Water.

4.4 Hypothesis testing

Hypothesis testing is a fundamental process in making a decision about populations of interest in survey whether a controlled experiment or an observational study. Furthermore, its a statistical tool that provides an objective framework for making decisions using a set of probabilistic methods, People could form different points of

view by looking at data, but a hypothesis test provides a uniform decision-making criterion that is consistent for everyone (Pereira and RN, 2009).

Hypothesis testing is made for a study which was based on information collected from a random sample of 132 questionnaire with 688 residents, following which results could be generalized for the entire population by checking the data consistency one by one with different confidence levels of 90%, 95% and 98% and with the following hypothesis.

Null hypothesis H_0: $\mu_1 = \mu_2$

Alternate hypothesis H_1: $\mu_1 \neq \mu_2$

It should be noted that the degree of freedom of the test is estimated using equation (4.2), while the confidence level was calculated using equation (4.3) (Mountgomery and Runger, 2007).

$$v = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(s_1^2 / n_1\right)^2}{n_1 - 1} + \frac{\left(s_2^2 / n_2\right)^2}{n_2 - 1}} \tag{4.2}$$

$$\overline{x}_1 - \overline{x}_2 - t_{\alpha/2,v}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \le \mu_1 - \mu_2 \le \overline{x}_1 - \overline{x}_2 + t_{\alpha/2,v}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \tag{4.3}$$

Where;

S_1: variance of sample one

S_2: variance of sample two

n_1: sample 1 size

n_2: sample 2 size

ν: degree of freedom

x_1: sample 1 mean of per capita daily water consumption

x_2: sample 2 mean of per capita daily water consumption

μ_1 : population 1 mean of per capita daily water consumption

μ_2 : population 2 mean of per capita daily water consumption

4.5 Criteria of water and energy savings analysis

4.5.1 Criterion of Water saving

Water saving devices play very important part of decreasing the amount of water consumed and considered one of the main policies which applied by countries to take actions because of environmental conditions and water lack .

The water saving devices available in Jordan are those used in toilets, showers, and faucets which was reported in water efficiency and public information for action (WEPIA) published by Ministry of Water and Irrigation in 2010. Other countries, such as the United States, have other devices for washing machines and dishwasher (Pennsylvania State University, 2005).

Pennsylvania State University, (2005) stated that the flow of water when use water saving devices which were manufactured after 1994, 6 Lpf, 5 Lpm and 8 Lpm for such appliances toilets, faucet aerators, and low flow shower head; respectively.

The calculation of water saving based on the assumptions given in Table (8) along with the following:

1. The average person showers 6 minutes each day, considering the flow rate through showering is 10L/min according to Pennsylvania state university survey and Ministry of Water was assumed 60 L/use water consumption per shower ,as result 60/10 = 6 min .

2. The average person uses faucets for 3.66 minutes each day according to ministry of water assumptions for water use interior homes .

While toilet western tank consumes 12L/f lush upon the sanitary and appliances ware stores. Considering the number of flushes per day for each person is at least one.

Table 9. The data needed for water saving calculations.

Appliances	Without water saving devices	Time of use assumed	With water saving devices,(after 1994) The Penn, State University,2005
Toilet flushing	12Lpf	1 flush /capita/day	6Lpf
Faucet aerator	6Lpm	3.66min /capita/day	5Lpm
Low flow shower heads	10Lpm	6 min /capita/day	8Lpm

The amount of water that can be saved when water saving appliances are used calculated by determining the daily water use for toilet, shower, and faucet in both cases when no water saving appliances adopted and with water saving appliances upon the relations, where:

Toilet use: the daily water use of toilet was the minimum times of flush per person daily multiplied by the number of house holders and the flow per flush (Pennsylvania State University, 2005).

Shower use: the daily water use of shower was the time needed per shower multiplied by the water flow per min and the number of householders (Pennsylvania State University, 2005).

Faucet use: the daily water use for faucet was the flow rate of water multiplied by the time of faucet per use and the number of house holders (Pennsylvania State University, 2005).

The daily water use with water saving devices calculated using the same steps above but the values substituted were the fourth column in Table (9) which is related to water saving flow. As result the daily water saving per capita equals the subtraction of daily per capita water use without and with water saving devices.

4.5.2 Criterion of Energy Saving calculation

The purpose of this criterion is to show how much energy could be saved if householders use water saving devices. the amount of heat that could be saved if the temperature through showering and faucet uses rises from 15 ºC to 41 ºC and 27 ºC; respectively calculated by equation (4.4). The choice of 15 ºC initial water temperature referred to the season of data collection which was autumn in October of 2010.

As result the annual money saving calculated by multiply the amount of heat saved with electrical Jordan tariff for the representative sample size and for the entire population for city .

$$Q = m\, C_p\, \Delta T \qquad \text{so} \quad m = d \times v \qquad (4.4)$$

Where:

Q: amount of heat saved , J/s

m: amount of water in grams.

d: density 1 g/cm^3.

V: volume of water saved.

C_p: heat capacity of water = 4.1855 J/g. K^0 at T= 15 ºC and P=101.325 Kpa (Cengel and Boles, 1998).

4.5.3 Money saving of water and energy bill

Water saving devices also can save money, as well as water and energy; the following way help to estimate the money that can be saved by installing proper water saving devices.

The cost of one cubic meter of water distributed to consumer householder is 1 JD (MWI, 2010). In Jordan the householders energy consumption is divided into four classes and tariffs as shown in Table (10). The amount of water and energy were multiplied by Jordan tariffs, as result, the annual money saving could be known according to the amount of water saved.

Table 10.Energy classes and tariff in Jordan.

Class of Energy consumption category	KWh	Fills/KWh	JD/KWh
Class 1	1-160	23	0.023
Class 2	161-300	72	0.072
Class 3	301-500	86	0.086
Class 4	>500	114	0.114

Source: Jordan National Electricity Company, 2011.

5. RESULT AND DISCUSSION

The study of residential water end uses is of great academic interest. The water scarcity and the increasing growth of population make this is the main reason behind the choice of the analysis of residential water use. Presentation and discussion of the obtained results will take the following order: household questionnaire analysis, hypothesis testing, and water and energy savings.

5.1 Sample size

The equation (4.1) yielded a sample size of 68, approximately. In order to avoid mishandling two hundred copies of the questionnaire were distributed all over residential quarters. The questionnaire was left with the householders for a week to fill their weekly use of water. 132 questionnaires were collected and 688 capita were covered by this study. The Collected data were analyzed using statistical methods.

5.2 Household Questionnaire Analysis

Figures and Tables demonstrate some percentages and results from the household questionnaire filled by the residents.

The questionnaires were analyzed after the data collected and the results were as follow, first of all Table (11) shows the 20 residential quarters and four administrative regions in Al-Salt city. It also shows the number of questionnaires that have been distributed randomly for a week and the number and percent of questionnaire collected from each region.

Table 11. Questionnaire distribution in the residential quarters in Al-Salt city.

Residential quarter	No. of questionnaire	% of total	Regions	No. of questionnaire	% of total
Wadi-Al'akrad	3	2.27%	Region 1	31	23.48%
Wadi-Al halaby	6	4.55%			
Al-Jad'ah	4	3.03%			
Al-Maydan	3	2.27%			
Al-Aizaryh	3	2.27%			
Al-Qal'ah	6	4.55%			
Al-Mnshyah	6	4.55%			
Al-Safih	19	14.39%	Region 2	71	53.79%
Sawada	4	3.03%			
Kuforhuda	3	2.27%			
Al-Mussla	5	3.79%			
Al-Salalim	40	30.30%			
Al-Siroo	8	6.06%	Region 3	18	13.64%
Al-Shaffa	3	2.27%			
Al-Naqab	7	5.30%			
Om-Zaytoonih	1	0.76%	Region 4	12	9.09%
Batna	3	2.27%			
Al-Myameen	4	3.03%			
Al-Qassam	2	1.52%			
Al-Mzawad	2	1.52%			
Total	132	100.00%			

To estimate the daily water consumption for each residential water use the frequency of uses was need in addition to the assumptions reported by Ministry of Water in Table (8), frequency of uses is the number of uses per family size such as, times of clothes washing and the number of cycles per wash, times of sink use (e.g, tooth brushing, hand washing, ablution and hair washing), times of showering. The Figure (20) indicates that hand washing frequency is higher than ablution followed by tooth bruising and finally laundry .Additionally the figure shows that sink has higher frequency of use, where sink use is the sum of hand washing, hair washing, ablution and tooth brushing.

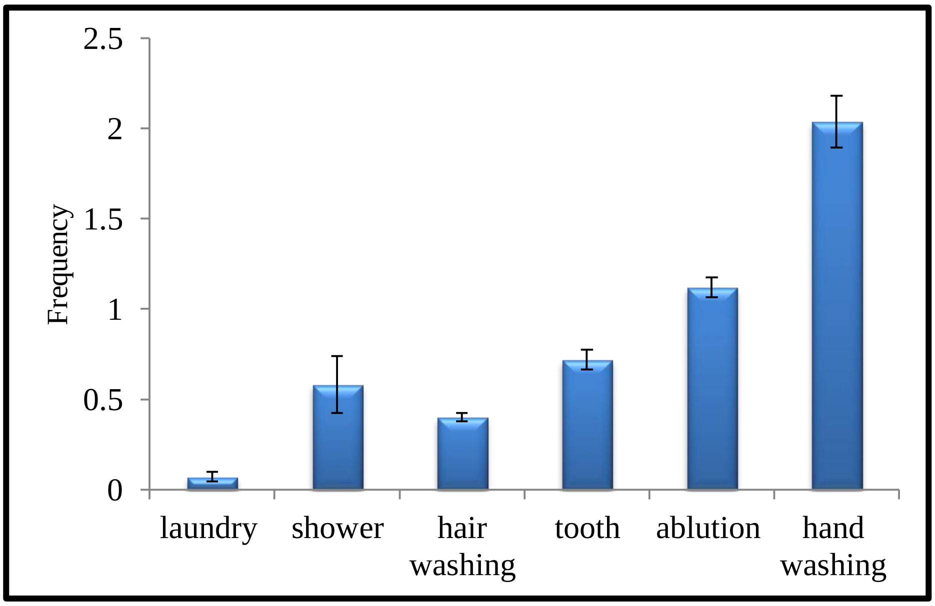


Figure 20. The average daily per capita frequency of internal residential use

As result , the average per capita daily water consumption for all internal water uses for four regions were shown in Figure (21) to Figure (26) which compared to the average value of the representative sample, noting that the average values of regions close to the average value for each region but this may not be accurate, in order to have the ability to make decisions if the average value of representative sample is the same for all regions or not an inference hypothesis statistical test was carried out .

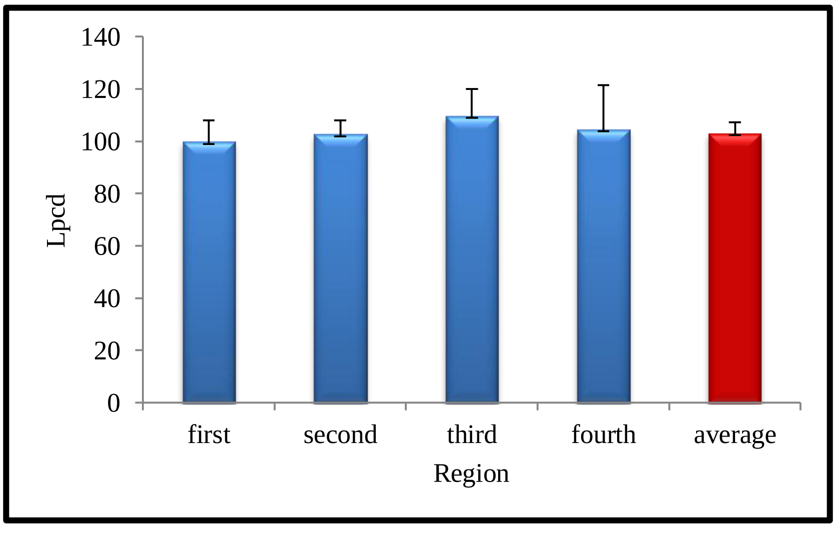


Figure 21. The average daily per capita water consumption .

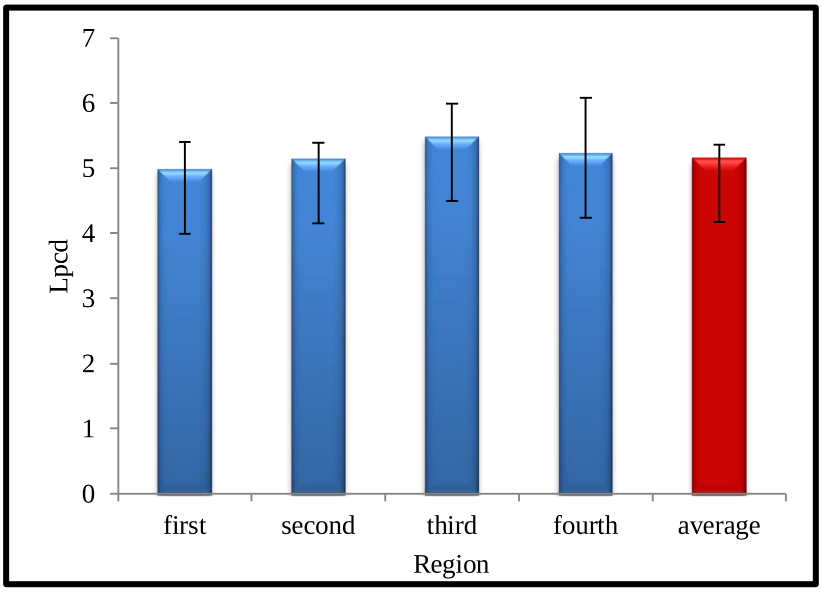
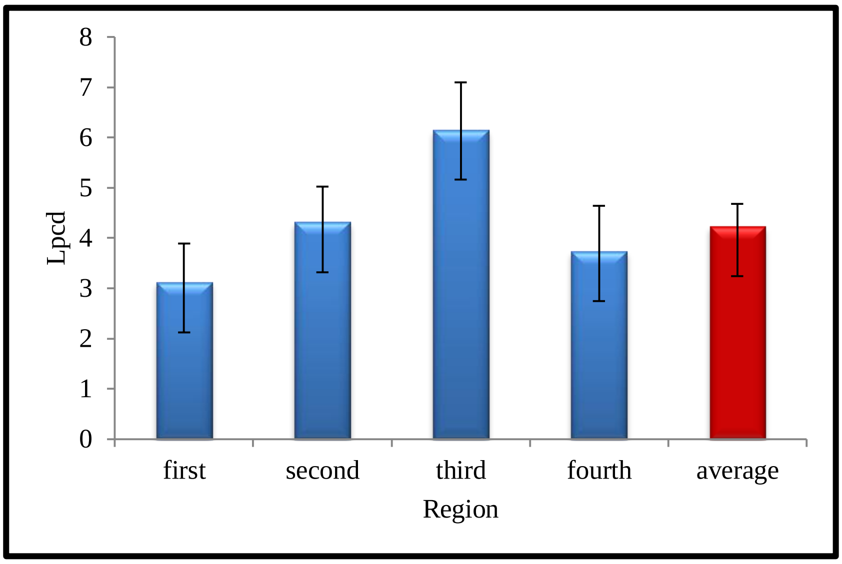


Figure 22. The average daily per capita water consumption for cooking.



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Figure 23. The average daily per capita water consumption for garden watering.

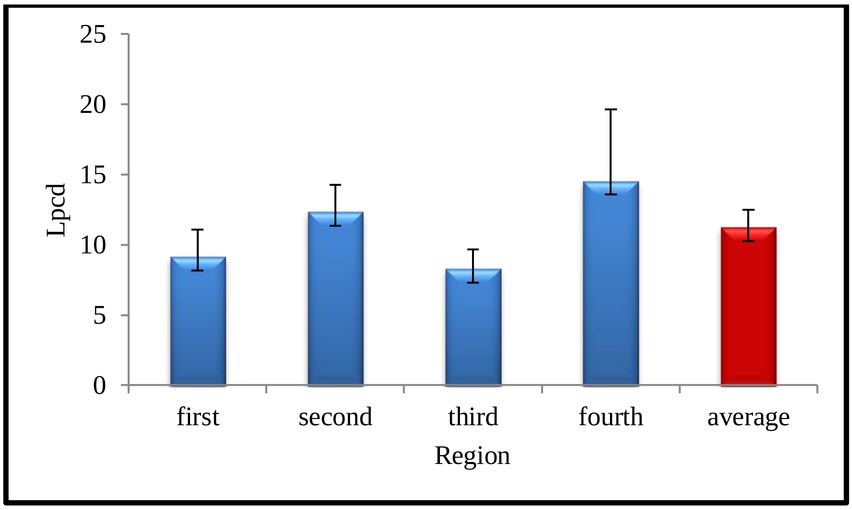


Figure 24. The average daily per capita water consumption for laundry.

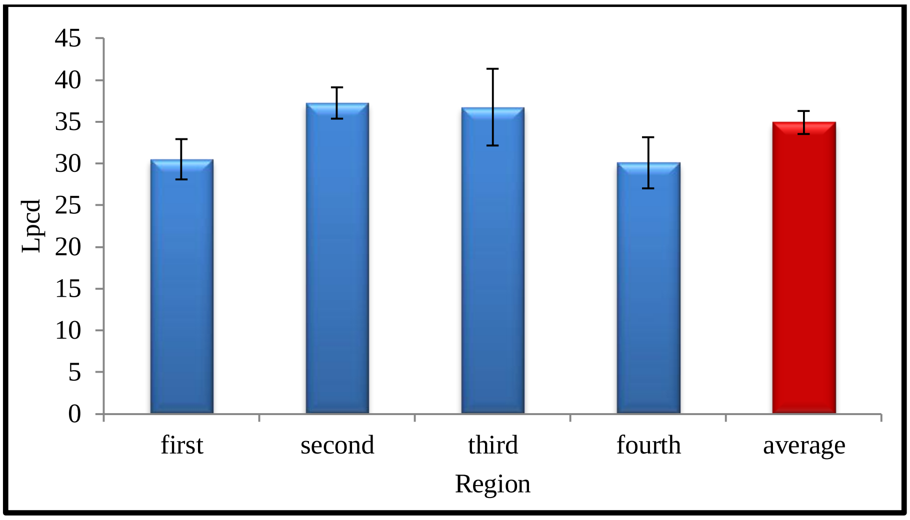


Figure 25. The average daily per capita water consumption for showering.

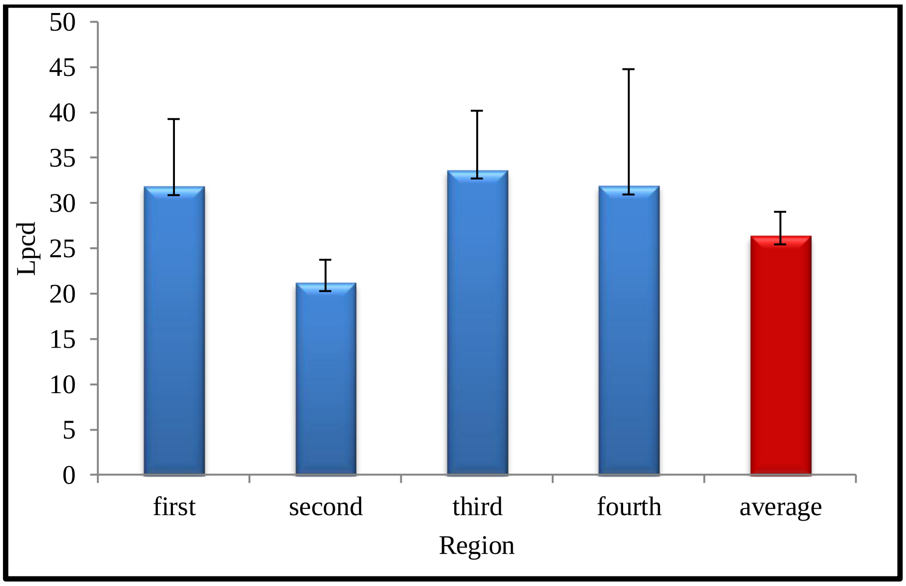


Figure 26. The average daily per capita water consumption for blackwater.

5.3 Hypothesis testing

The per capita daily water consumption was compared by hypothesis testing which was carried out at different confidence level, 90%, 95% and 98% to Examine the entire data for the 20 residential quarters in Al-Salt city confirmatory and consistency which depends on probability, for example ,region one consists of seven residential quarters which are Al-Jad'ah, Al-Aizaryh, Al-Qal'ah , Al-Mnshyah , Al-Maydan , Wadi-Al'akrad, and Wadi-Alhalaby the comparing started from first residential quarter where obviously indicated in Table (11).

When the comparison was finished for each region with its residential quarters, an additional comparison was carried out for all regions of the city. The values of mean, variance, and degree of freedom were calculated.

The t-test with two tailed was employed because of the unknown variance of the two samples of population, the t values were also estimated according to the degree of freedom values which were reported by (Mountgomery and Runger, 2007) and on confidence level.

All these values were substituted in equation (4.3) and the two hypothesis were checked null and alternate hypothesis, as result Tables from (12) to (16) show that the values which were between upper and lower limits at different confidence levels and the means of all residential quarters and regions were statistically not significant, in other words $\mu_1=\mu_2$ and the null hypothesis achieved within the region of acceptance. A conclusion was came up through considering all residential quarter and their regions were the same, so. The estimation of residential water end use analysis and distribution of the representative sample on the entire city could be generalized.

The per capita daily water consumption for all uses for four regions in Al-Salt city is shown in Table (17), where the overall per capita daily water consumption concluding, sink, garden watering, cooking and drinking, laundry, black water and showering with average values 21.332, 4.239, 5.168, 11.2747, 26.4172, and 34.933 Lpcd respectively, with average per capita daily water consumption 103.364 Lpcd, where regions split into 75% were above the average value and 25% below the average value, furthermore the average daily water consumption per capita estimated is lower than the average daily water consumption per capita which was reported by Ministry of Water and Irrigation and Water Authority of Al-salt city ,where the per capita daily water consumption of Balqa'a governorate was 145 and 170 Lpcd for Al-Salt city in the year 2010 (MWI and WAJ, 2010).

Also the estimated per capita water consumption of Al-Salt city is greater than those estimated for Irbid ,Rusaifa and Zarqa ,where the per capita daily consumption were 82.7,69.9 and 82.3; respectively (Jamrah and Ayyash , 2008) .

In addition the Table (17) shows the sink use which consisted of tooth brushing, hand washing, ablution as well as hair washing. Jamrah and Ayyash (2008) reported that the average daily water consumption of sink use for Irbid, Rusaifa and Zarqa were 31.2,25.1,and 35.9 Lpcd ,respectively which higher than the estimated value for Al-Salt city .

The distribution of residential water uses in Al-Salt city is shown in Figure (27), where the percent of internal water use for shower is higher than black water, sink ,laundry ,garden watering and cooking and drinking ,while the percent of internal water use for garden watering is lower than others .

Table 12. Comparison of the daily average per capita water consumption for first region at different confidence level using hypothesis test

Variable	Size	Mean	Variance	Degree of Freedom	98			95			90		
					t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit
Aljad'h	4	82.2	434.25533	3	4.541	-1005.43	991.63	3.182	-706.60	692.80	2.353	-524.31	510.51
Al-aizaryh	3	75.3	60.209084										
Aljad'h	4	82.2	434.25533	9	2.821	-1199.92	1242.00	2.262	-957.98	1000.06	1.833	-772.30	814.38
Al qal'ah	6	103.239	917.109										
Aljad'h	4	82.2	434.25533	9	2.821	-829.81	842.76	2.262	-664.10	677.05	1.833	-536.92	549.87
Al manshyah	6	88.675	494.4										
Aljad'h	4	82.2	434.25533	5	3.365	-1446.48	1424.45	2.571	-1107.77	1085.74	2.015	-870.58	848.56
Al meedan	3	71.189	636										
Aljad'h	4	82.2	434.25533	7	2.998	-788.37	837.73	2.365	-616.70	666.06	1.895	-489.24	538.60
Wadi alakrad	3	106.88	281.44										
Aljad'h	4	82.2	434.25533	5	3.365	-6725.16	6846.65	2.571	-5123.97	5245.46	2.015	-4002.73	4124.22
Wadi al halaby	6	142.9454	4910.96										
Al-aizaryh	3	75.3	60.21	5	3.365	-1237.36	1293.24	2.571	-938.80	994.68	2.015	-729.74	785.62
Al qal'ah	6	103.239	917.109										
Al-aizaryh	3	75.3	60.21	5	3.365	-675.81	702.56	2.571	-513.19	539.94	2.015	-399.32	426.07
Al manshyah	6	88.675	494.4										
Al-aizaryh	3	75.3	60.21	2	6.965	-2573.06	2564.84	4.303	-1591.21	1582.99	2.92	-1081.11	1072.89
Al meedan	3	71.189	636										
Al-aizaryh	3	75.3	60.21	2	6.965	-1125.77	1188.93	4.303	-683.43	746.59	2.92	-453.63	516.79
Wadi alakrad	3	106.88	281.44										
Al-aizaryh	3	75.3	60.21	5	3.365	-6679.83	6815.12	2.571	-5087.70	5222.99	2.015	-3972.82	4108.11
Wadi al halaby	6	142.9454	4910.96										
Al qal'ah	6	103.239	917.109	9	2.821	-1214.47	1185.34	2.262	-976.70	947.57	1.833	-794.22	765.10
Al manshyah	6	88.675	494.4										
Al qal'ah	6	103.239	917.109	8	2.896	-1550.76	1486.66	2.306	-1241.36	1177.26	1.86	-1007.47	943.37
Al meedan	3	71.189	636										
Al qal'ah	6	103.239	917.109	7	2.998	-1219.98	1227.27	2.365	-961.63	968.91	1.895	-769.80	777.08
Wadi alakrad	3	106.88	281.44										

Variable	Size	Mean	Variance	Degree of Freedom	98			95			90		
					t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit
Al qal'ah	6	103.239	917.109	5	3.365	-6823.38	6902.80	2.571	-5203.98	5283.39	2.015	-4069.99	4149.40
Wadi al halaby	6	142.9454	4910.96										
Al manshyah	6	88.675	494.4	4	3.747	-1587.52	1552.55	2.776	-1180.66	1145.69	2.132	-910.82	875.85
Al meedan	3	71.189	636										
Al manshyah	6	88.675	494.4	9	2.821	-712.76	749.17	2.262	-567.92	604.33	1.833	-456.76	493.17
Wadi alakrad	3	106.88	281.44										
Al manshyah	6	88.675	494.4	5	3.365	-6726.29	6834.83	2.571	-5126.36	5234.90	2.015	-4006.01	4114.55
Wadi al halaby	6	142.9454	4910.96										
Al meedan	3	71.189	636	4	3.747	-1468.88	1540.26	2.776	-1078.99	1150.37	2.132	-820.39	891.78
Wadi alakrad	3	106.88	281.44										
Al meedan	3	71.189	636	5	3.365	-6786.92	6930.43	2.571	-5168.56	5312.07	2.015	-4035.30	4178.81
Wadi al halaby	6	142.9454	4910.96										
Wadi alakrad	3	106.88	281.44	5	3.365	-6732.51	6804.64	2.571	-5135.41	5207.54	2.015	-4017.04	4089.17
Wadi al halaby	6	142.9454	4910.96										

Table 13. Comparison of the daily average per capita water consumption for the second region at different confidence level using hypothesis test

Variable	Size	Mean	Variance	Degree of Freedom	98			95			90		
					t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit
Alsalalim	40	103.8	1567.8	26	2.479	-1505	1523	2.056	-1247	1265	1.706	-1033	1051
Alsafeh	19	112.9	2433										
Alsalalim	40	103.8	1567.8	42	2.4	-606.4	604.3	2.019	-510.2	508.2	2.01	-508	506
Al musala	5	102.7	104.12										
Alsalalim	40	103.8	1567.8	18	2.552	-909.1	829.9	2.101	-755.4	676.2	1.734	-630	551.2
Sawada	4	64.17	467.48										
Alsalalim	40	103.8	1567.8	30	2.457	-735.9	691.5	2.042	-615.4	570.9	1.697	-515	470.7
Kuforhuda	3	81.53	262.26										
Alsafeh	19	112.9	2433	18	2.552	-1440	1419	2.101	-1187	1167	1.734	-981	961.1
Al musala	5	102.7	104.12										
Alsafeh	19	112.9	2433	23	2.5	-1562	1464	2.069	-1301	1203	1.714	-1086	988.5
Sawada	4	64.17	467.48										
Alsafeh	19	112.9	2433	20	2.528	-1493	1431	2.086	-1238	1175	1.725	-1029	966.3
Kuforhuda	3	81.53	262.26										
Al musala	5	102.7	104.12	3	4.541	-1121	1044	3.182	-796.9	719.8	2.353	-599	522.2
Sawada	4	64.17	467.48										
Al musala	3	75.3	60.21	2	6.965	-1076	1088	4.303	-662.3	674.7	2.92	-447	459.9
Kuforhuda	3	81.53	262.26										
Sawada	4	64.17	467.48	6	3.143	-858	892.7	2.447	-664.1	698.8	1.943	-524	558.5
Kuforhuda	3	81.53	262.26										

Table 14. Comparison of the daily average per capita water consumption for third region at different confidence level using hypothesis test

Variable	Size	Mean	Variance	Degree of Freedom	98			95			90		
					t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit
Al siroo	8	111.5	1524.1	4	3.747	-4741	4782	2.776	-3507	3548	2.312	-2918	2958
Al shafa	3	131.6	1993.3										
Al siroo	8	111.5	1524.1	15	2.602	-2028	2002	2.131	-1663	1637	1.753	-1370	1345
Al naqab	7	98.77	1471.3										
Al shafa	3	131.6	1993.3	4	3.747	-4822	4756	2.776	-3581	3515	2.312	-2988	2922
Al naqab	7	98.77	1471.3										

Table 15. Comparison of the daily average per capita water consumption for fourth region at different confidence level using hypothesis test

Variable	Size	Mean	Variance	Degree of Freedom	98			95			90		
					t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit
Al qassam	2	95.81	435	1	31.82	-125380	125570	12.71	-50006	50197	6.314	-24802	24992
Al mzawad	2	191.2	5559.5										
Al qassam	2	95.81	435	1	31.82	-9840.3	9773.7	12.71	-3949	3882.6	6.314	-1979	1912.6
Al myameen	4	62.48	38.4										
Al qassam	2	95.81	435	1	31.82	-9806.8	9769.1	12.71	-3927	3889.5	6.314	-1961	1923.3
Om zaytoonih	1	76.98	0										
Al qassam	2	95.81	435	4	3.747	-1470.4	1516.6	2.776	-1083	1129.6	2.132	-826.7	872.88
Batna	3	118.9	439.04										
Al mzawad	2	191.2	5559.5	1	31.82	-125223	124966	12.71	-50078	49821	6.314	-24950	24693
Al myameen	4	62.48	38.4										
Al mzawad	2	191.2	5559.5	1	31.82	-125207	124979	12.71	-50063	49835	6.314	-24935	24707
Om zaytoonih	1	76.98	0										
Al mzawad	2	191.2	5559.5	1	31.82	-125425	125280	12.71	-50125	49981	6.314	-24945	24801
Batna	3	118.9	439.04										
Al myameen	4	62.48	38.4	3	4.541	-72.689	101.69	3.182	-46.6	75.593	2.353	-30.68	59.676
Om zaytoonih	1	76.98	0										
Al myameen	4	62.48	38.4	2	6.965	-1714.1	1827	4.303	-1037	1150.3	2.92	-685.8	798.71
Batna	3	118.9	439.04										
Om zaytoonih	1	76.98	0	2	6.965	-1723.5	1807.4	4.303	-1049	1132.7	2.92	-698.2	782.09
Batna	3	118.9	439.04										

Table 16. Comparison of the daily average per capita water consumption for four region at different confidence level using hypothesis test

Variable	Size	Mean	Variance	Degree of Freedom	98			95			90		
					t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit	t-value	Lower Limit	Upper Limit
Region 1	31	95.78	1104.9	52	2.36	-543.76	538.2	2.01	-463.53	458	1.6762	-387.01	381.49
Region 2	71	93.02	966.92										
Region 1	31	95.78	1104.9	27	2.473	-1068.3	1105	2.052	-883.32	919.7	1.703	-729.99	766.35
Region 3	18	114	1662.9										
Region 1	31	95.78	1104.9	19	2.539	-1060.9	1088	2.093	-872.22	898.8	1.729	-718.22	744.81
Region 4	12	109.1	1294.4										
Region 2	71	93.02	966.92	20	2.528	-1011.5	1053	2.086	-830.99	872.9	1.725	-683.56	725.43
Region 3	18	114	1662.9										
Region 2	71	93.02	966.92	14	2.624	-1009.6	1042	2.145	-822.38	854.5	1.761	-672.28	704.39
Region 4	12	109.1	1294.4										
Region 3	18	114	1662.9	29	2.462	-1338.1	1328	2.045	-1112.3	1103	1.699	-924.93	915.16
Region 4	12	109.1	1294.4										

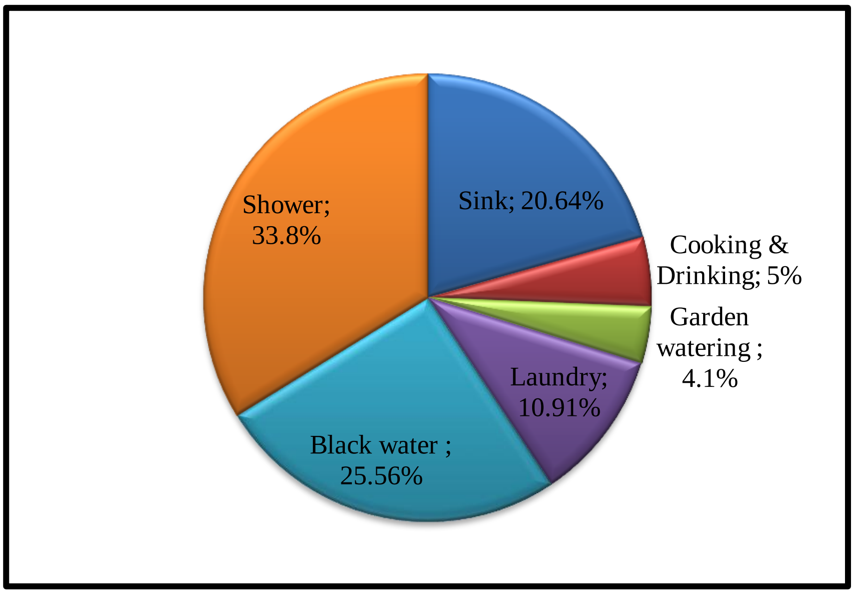


Figure 27. The distribution of residential water uses in Al-Salt city

When comparing the results of percent of residential internal water uses for Jordanian cities according to (Jamrah and Ayyash, 2008) and (Jamrah et al., 2008) with the estimated percentage of Al-Salt city which are shown in Figure (28), Al-Salt had the lower percentage of water consumption for sink, garden watering and laundry, in other words Zarqa had higher percentage of water consumption for sink as well as Rusaifa higher percentage of water consumption for laundry and garden watering. Al-Salt showed the maximum percentage of use for showering and blackwater, however the percentage of cooking use for all cities were slightly close to each other. In addition, the percentage of water consumption uses in Al-Salt city where compared to those reported for Jordan such as, laundry, sink, and shower uses.

Al-Salt city have lower percentage of water consumption for laundry and sink use than those 14%and 47% reported by Ministry of Water and Irrigation for Jordan in 2010, respectively, but higher percentage of water consumption for shower use than 19% that reported by Ministry of Water and Irrigation for Jordan in 2010.

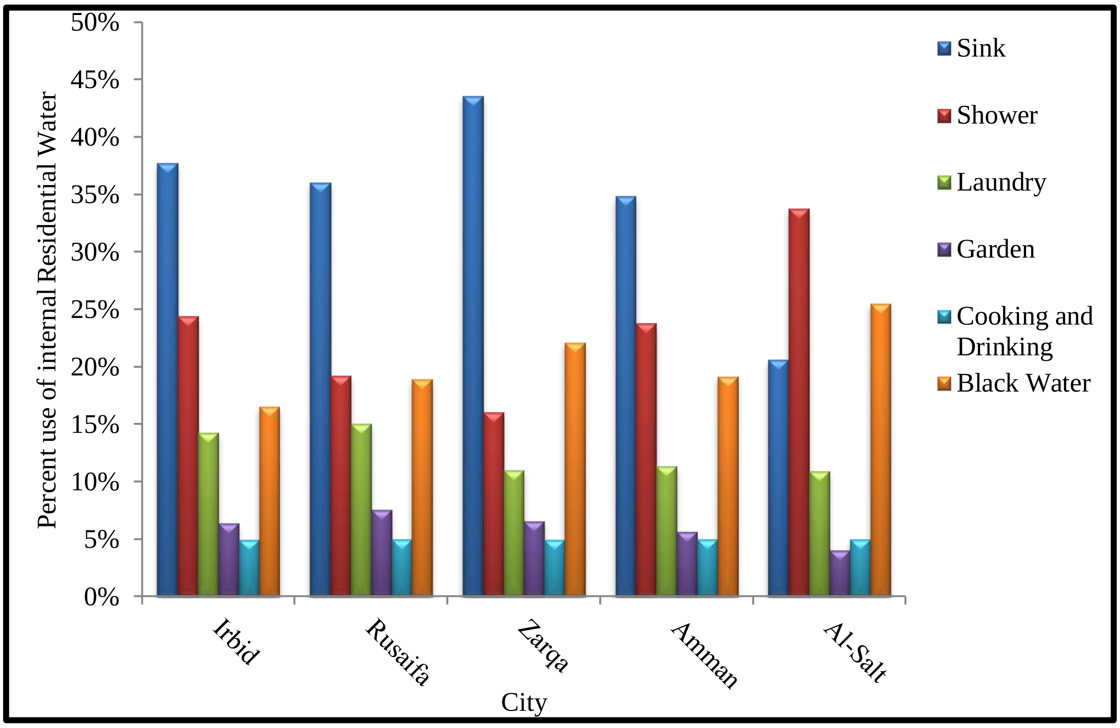


Figure 28. Comparison between the per capita rate of internal water consumption for the different internal water uses for Al-Salt with different cities in Jordan.

Table 17. Daily water consumption for internal residential water uses ,Lpcd

	Sink	Hand washing	Ablution	Tooth	Hair washing	Shower	Laundry	Water consumption	Cooking	garden	Black water
Region 1	20.25	3	13.08	1.566	2.4	30.49	9.2	100	4.997203	3.127753	31.89691
Maximum	25.48	4	16.86	2.395	3.67	37.22	15	143	7.147271	6.631133	64.49102
Minimum	12.57	2	8	0.805	1.57	20.36	2	71	3.559466	0	17.49811
Region 2	22.63	5	14.1	1.378	2.63	37.23	12	103	5.148023	4.321379	21.2527
Maximum	36.15	8	23	1.837	3.53	47.51	15	113	5.644309	6.685897	30.59319
Minimum	14.77	3	9.236	0.572	1.52	21.05	2	64	3.208333	1.61037	5.253913
Region 3	19.5	3	12.44	1.549	2.04	36.73	8.3	110	5.494369	6.159713	33.67484
Maximum	24.24	4	16.57	2.011	2.31	38.88	9	132	6.581528	7.061167	50.76392
Minimum	14.9	3	8.542	1.104	1.71	34.44	7.7	99	4.938585	4.889266	21.26157
Region 4	19.22	4	12.19	1.175	1.73	30.1	15	105	5.240105	3.74038	31.93153
Maximum	27.71	8	16.5	1.386	2.1	42.43	27	191	9.558031	7.13524	99.82519
Minimum	7.31	2	4	0.66	1	11.43	8.1	62	3.124228	1.841667	4.80722
Weighted average	20.97	4	13.4	1.439	2.31	33.4	9.5	104	5.195919	4.422706	30.86177
Average	21.33	4	13.46	1.427	2.41	34.93	11	103	5.168204	4.238922	26.41721
Overall max	36.15	8	23	2.395	3.67	47.51	27	191	9.558031	7.13524	99.82519
Overall min	7.31	2	4	0.572	1	11.43	2	62	3.124228	0	4.80722

5.4 Water and energy savings

5.4.1 Water saving

Water saving can be calculated using the assumptions in Table(8) ,Table (9), and criterion mentioned in methodology chapter. Table (18) shows the water used without and with water saving appliances for toilet, shower and faucet end uses for the representative sample size and for the whole population of city, in addition the survey indicated that 89.31% accepted the use of water saving appliances and all calculation was repeated to 89.31% to coming out with real amount of water that can be saved. The amount of water which can be saved valuable where 40 m^3/family approximately saved yearly as well as money.

In addition, the amount of water that can be saved yearly for 85034 person with 17007 families who have the willingness to use water saving appliances is 592267 m^3 which is valuable amount of water, as result each family of the entire city could be saved 34.82 m^3 /year, while each family of 75955 person which achieved 89.31% who accepted the use of water saving devices is 39 m^3 /year approximately. Table (19) shows the amount of daily, monthly and yearly water saved when water saving appliances are used.

The percentage of water saving in toilet, shower and faucet presented rating 23.1 % which is less than 35% reported in water efficiency and public information for action project (WEPIA) (MWI, 2010). Also the higher percent of water saving was for toilet where 50% saved and the lower percent of water saving was for faucet .

Table 18. The amount of water that can be saved for the representative sample and for the entire city population for each use.

	100% of representative sample			89.31% of representative sample			
	Water used without water saving appliances liter per day	Water used with water saving appliances Liter per day	Amount of water saved liter per day	Water used without water saving appliances liter per day	Water used with water saving appliances Liter per day	Amount of water saved liter per day	percent of water saved
Faucet	15108	12590	2518.08	13493.3	11244.435	2248.887	16.67%
Shower	41280	33024	8256	36867	29493.6	7373.4	20%
Toilet	8256	4128	4128	7373.4	3686.700	3686.7	50%
Total use	64644	49742	14902.1	57733.7	44424.735	13308.987	23.1%
	100% of the entire city population			89.31% of the entire city population			
	Water used without water saving appliances liter per day	Water used with water saving appliances Liter per day	Amount of water saved liter per day	Water used without water saving appliances liter per day	Water used with water saving appliances Liter per day	Amount of water saved liter per day	percent of water saved
Faucet	2E+06	2E+06	311224	1667972	1389976.5	277995.3	16.7%
Shower	5E+06	4E+06	1020408	4557300	3645840	911460.0	20.0%
Toilet	1E+06	510204	510204	911460	455730	455730	50.0%
Total use	7E+06	5E+06	1645185	7136732	5491546.5	1645185.3	23.1%

Table 19. Per capita daily water consumption without and with water saving devices, the amount of water saved, monthly saved and annual money saving.

Householders number	Number of families	Water saved L/day	Water Saved liter /month	Water saved, m^3/month	Water saved m^3/year	Water saved per family m^3/year
688	132	14902.1	447062.4	447.0624	5364.7	40.64204
614	122	13309	399269.61	399.26961	4791.2	39.27242
85034	17007	1645185	49355559	49355.559	592267	34.82488
75955	15191	1645185	49355559	49355.559	592267	38.988

People responses to the questions about water saving devices, where the survey concluded that 65.91% of respondents were familiar with the concept of water saving devices and 34.09% of respondents answered they never heard about water saving appliances, this result indicated that people well known of the concept. In addition, 89.31% of respondents prefer to use water saving appliances while 10.69% they refuse the use of water saving devices, and that indicated in Figure (29).

The responses to question of where they prefer use water saving devices, the higher percentage of preference was to kitchen sink and faucet that refer to their point of view where the higher water consumption was for kitchen sink and faucet, while laundry was the lower percentage of preference of water saving devices use that shown in Figure (30).

People opposing the use of water saving devices for many reasons where shown in Figure (31) 41.18% of respondents not sure about water saving devices efficiency in saving water, 35.29% of respondents thought its costly and 23.53% of respondents afraid of its harmful affects on appliances such as damage.

The prices of water saving appliances from their point of view were shown in Figure (32) where the frequencies for each price also concluded, as a result, 0.15 JD is the lower price expected by respondents while 35 JD is the higher price expected ,but the water efficiency and public information for action project reported the prices of water saving devices in Jordan which were between 2.5-20 JD by (MWI , 2010) .

the expected percent of water that can be saved if use water saving appliances is shown in Figure (33),where most people thought the percentage of water saving rating 30% which was very closed to that reported in WEPIA.

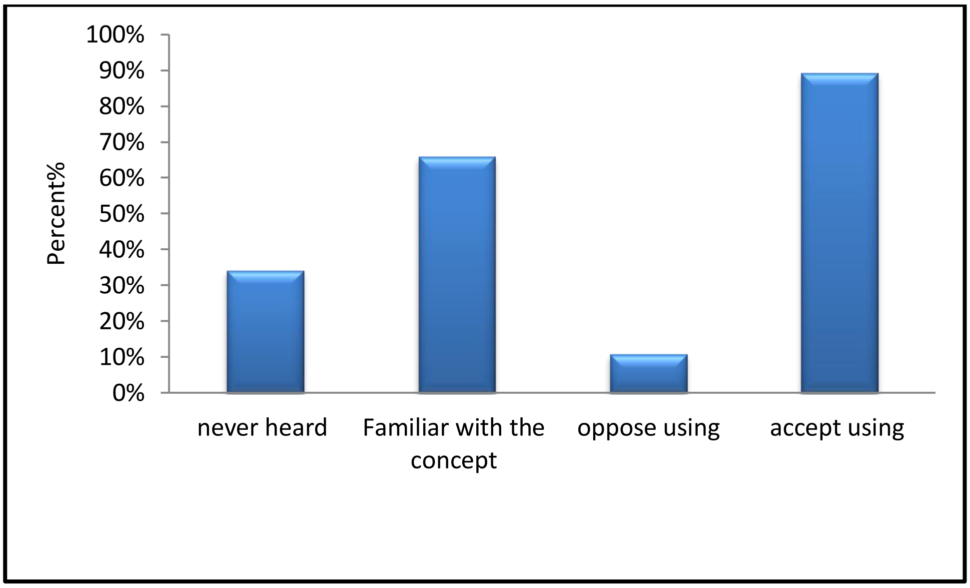


Figure 29. Percent of public familiarity and acceptance of water saving appliances

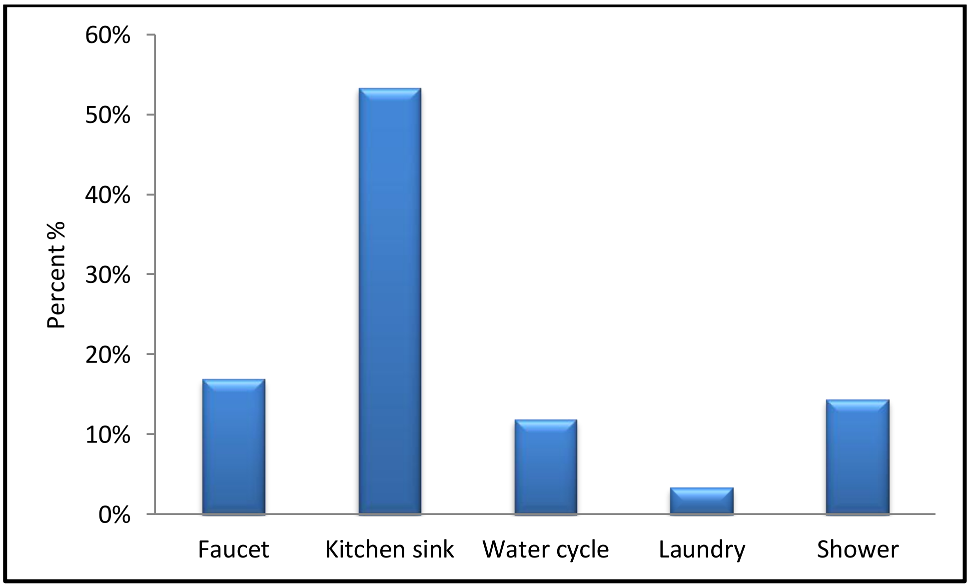


Figure 30. Responses of where they prefer to use water saving devices

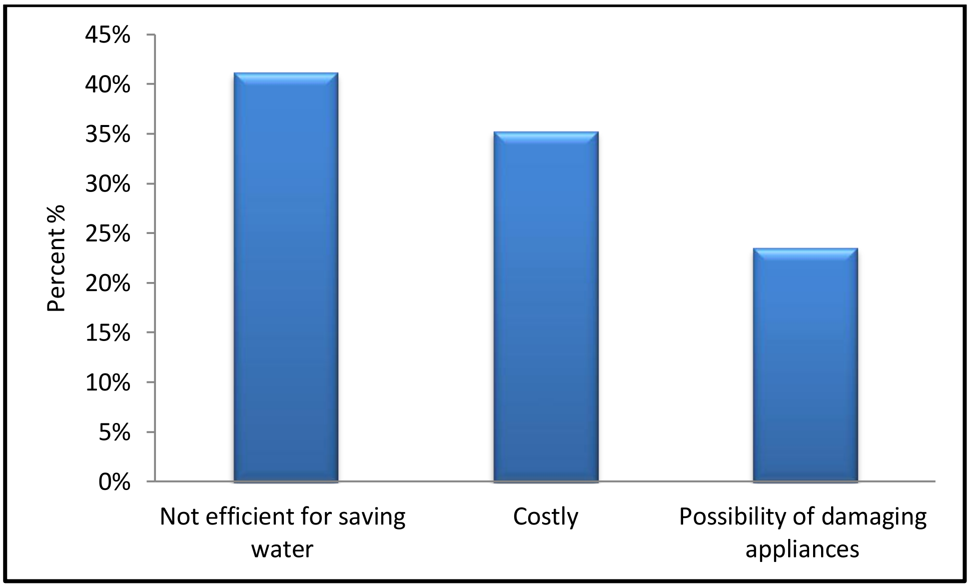


Figure 31. Reasons of opposing the use of water saving devices.

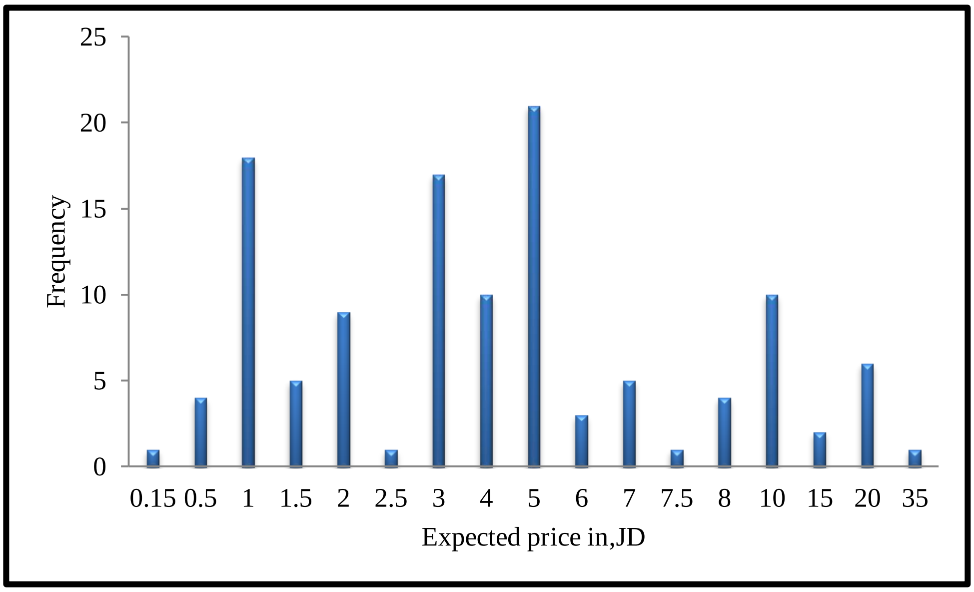


Figure 32. Expected prices of water saving devices

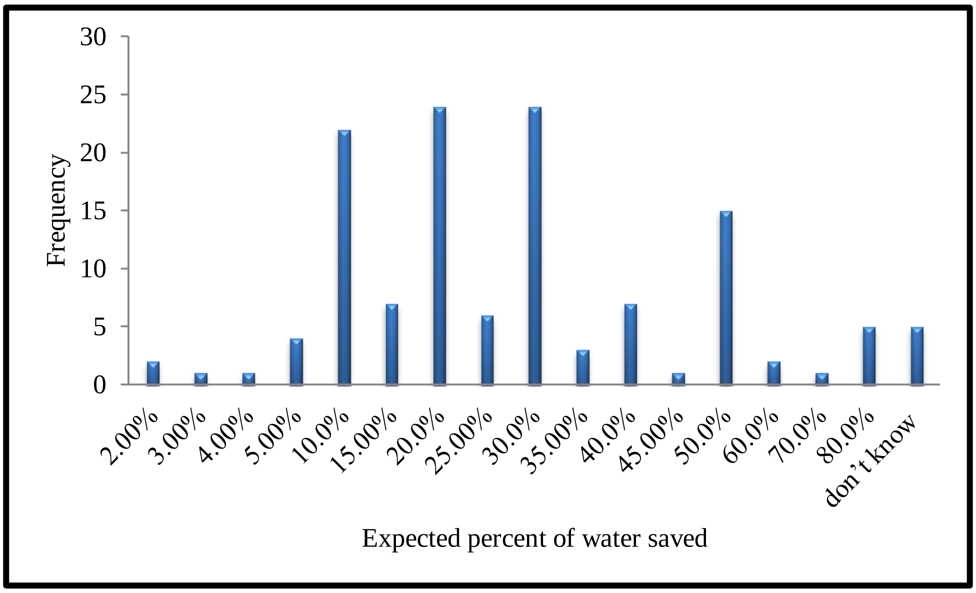


Figure 33. Percentage of expected amount of water that can be saved when use water saving devices.

5.4.2 Energy savings

Water saving appliances not only saving water but also save energy, the energy saved for shower and faucet uses calculated according to the amount of water saved for both uses when temperature through showering and faucet uses rise from 15 ºC to 41ºC and 27 ºC. Table (20) shows the amount of energy that can be saved for different energy tariff classes if residents use water saving appliances on faucets and shower heads. According to survey 89.31% of respondents accepted the use of water saving devices, as result the amount of energy that can be saved for 100% and 89.31% of questionnaire sample and entire population of city were calculated for each family ,where the number of families for questionnaire was 132 with average family size of 5 person and the number of population of Al-Salt city is 85034 and the number of families equal 17007 considering average family size of 5 person.

Noting that the amount of energy that can be saved for shower use is greater than that for faucet use and that refer to temperature rising, also the annual money saving for the 89.31% of entire population is grater than that for 89.31% of questionnaire sample size,

and lower than 100% of entire population of city and 100% of questionnaire sample . Also the amount of annual money saving computed per family to convince people of the importance of water saving appliances use in order to save both water and energy. Also the table indicated the amount of energy which can be saved yearly per family comprised 755-787 KWh and that refer to the number of population which the study covered or the entire population of Al-Salt city and the percent of residents acceptance to use water saving appliances.

Table 20. Amount of energy saved and the annual energy money saving for the questionnaire sample and entire population of Al-Salt city

	Amount of water saved L/d	J/day	Watt	Class	Price	KW	KWh/ daily	Yearly energy saving	Energy saved yearly per family	Annual money saving for shower	Annual money saving for faucet	Total money saving	Saving per family	
shower	8256	8.98E+08	10398.6	class 1	0.023	10.399	249.57	91092	690.09	2095.12	294.93	2390	18.106	for 132 families of 688 householders
faucet	2518.08	1.26E+08	1463.81	class 2	0.072	1.464	35.131	12823	97.144	6558.63	923.25	7482	56.681	
				class 3	0.086					7833.92	1102.8	8937	67.70	
				class 4	0.114					10384.5	1461.8	11846	89.75	
	amount of water saved L/d	J/day	Watt	class	Price	KW	KWh/ daily	energy saved yearly	Energy saved yearly per family	annual money saving for shower	annual money saving for faucet	total money saving	saving per family	for 122 families of 614 householders who accepted the use of water saving devices
shower	7373.4	8.02E+08	9286.99	class 1	0.023	9.287	222.89	81354	666.84	1871.14	263.4	2135	17.49	
faucet	2248.89	1.13E+08	1307.32	class 2	0.072	1.307	31.376	11452	93.87	5857.49	824.55	6682	54.77	
				class 3	0.086					6996.44	984.88	7981	65.42	
				class 4	0.114					9274.35	1305.5	10580	86.72	

	Amount of water saved L/d	J/day	Watt	Class	Price	KW	KWh/ daily	Yearly energy saved	Energy saved yearly per family	Annual money saving for shower	Annual money saving for faucet	Total money saving	Saving per family	
shower	1020408	1.11E+11	1285230	class 1	0.023	1285.23	30846	1125861.4	662	258948	36452	3E+05	17.37	for 17007 families of 85034 householders of the entire city
faucet	311224	1.56E+10	180921	class 2	0.072	180.92	4342.1	1584866	93.189	810620	114110	9E+05	54.37	
				class 3	0.086					968241	136299	1E+06	64.95	
				class 4	0.114					1283482	180675	1E+06	86.09	

	Amount of water saved L/d	J/day	Watt	Class	Price	KW	KWh/ daily	Yearly energy saved	Energy saved yearly per family	Annual money saving for shower	Annual money saving for faucet	Total money saving	Saving per family	
shower	911460	9.92E+10	1148007	class 1	0.023	1148.01	27552	10056542	662.01	231300	32560	3E+05	17.37	for 15191 families of 75955 house holders
faucet	277995	1.4E+10	161604	class 2	0.072	161.60	3878.5	1415652	93.19	724071	101927	8E+05	54.37	
				class 3	0.086					864863	121746	1E+06	64.95	
				class 4	0.114					1146446	161384	1E+06	86.09	

also the survey came out of many information about the study sample such as householders entertainments in their residence type, which were house, flat and multistory, in addition the class and category of residence area, 47.73% reside in class A, 24.24% reside in class B, 27.27% reside in class C, and 0.76% reside in urban development.

Moreover , the study sample varied in their income , people usually do not like to share information about their monthly income and if they do maybe its inaccurate, even though the questionnaire concludes that the majority of the sample are in the middle class, where the fixture income is: 6.87% rating below 250 JD, 28.24% rating 250-350 JD, 22.14% rating 351-450 JD, 20.61% rating 451-550 JD, rating more than 550 JD 22.14% .

People had many water sources, 12.88% of respondents use water authority and well, but 87.12% of respondents use water authority and their our source of water , as result people rely on water supply by water authority and wells.

Furthermore 81.82% of Respondents own cars and 66.67% of them wash their car once weekly while 29.63 % of respondents wash their cars twice and the higher times of car washing is three.

The study tried to relate the above variables such as class category, residence type and income variation with amount of water consumed for each family.

Families could have higher income rate but low water consumption and that refer to family size which was low while other families have large family size but low water consumption this result refer to family age ranges which was above 25 years where those spend most of their time at work . However, families who had age ranges between

1 year old to 18 year old unique of its higher consumption rate of water. Also families with high income rate live in houses and their class category varied between A to B.

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusions

This study was carried out to evaluate the distribution of internal domestic fresh water use and the frequency of internal domestic water uses in Al-Salt city. Also estimated the average water consumption per capita. Moreover, the perception of householders acceptance or rejection for using water saving devices were gauged and analyzed , in addition estimated the amount of water saving and money revenue.

The study employed a social survey method. A questionnaire was designed and administered in Al-Salt city to achieve the purposes of the survey. The study concluded that the per capita water consumption for fourth regions of Al-Salt city ranged between 62.48 and 191.16 liter per capita with average water consumption 103 liter per capita, where 75% of the regions above the average value and 25% are below the average value. Sink, cooking and drinking ,garden watering ,laundry, blackwater and showering effluents comprised 20.64%, 5%,4.1%, 10.91%, 25.56% and 33.8% ; respectively of average total daily water consumption per capita. The result of the representative sample can be generalized on the entire city according to inference statistical test called hypothesis testing where the mean is not statistically significant.

The study revealed that the adoption of Water Saving Devices by 23.1% of internal domestic water consumption in Al-Salt city provided potential water savings of about 447 m^3 over a month period in a cost effective manner with 41 m^3 could be saved yearly per family for the 100% of representative sample .also the 100% of entire population of Al-Salt city could save 35 m^3 /year while 39 m^3 /year saved for 89.31% who accepted the use of water saving devices for both of entire population and representative sample. In addition the amount of energy that can be saved where estimated according to

temperature rising through showering and faucet uses from $15C^0$ to 41 C^0 and 27 C^0; respectively. The amount of energy that can be saved if people use the water saving devices on shower and faucet were extremely valuable, 103915KWh saved yearly for 100% of representative sample as well as 787 KWh saved per family yearly .in addition 92806 KWh can be saved yearly for 89.31% of representative sample who accept the use of water saving devices .

The outcome of the survey indicated that 34.09% of the respondents never heard about water saving appliances. And 65.91% where familiar with the concept, also the acceptance for using water saving appliances were gauged, in addition to find out the reason of opposing the use of water saving devices. Moreover, people think that water saving appliances price between 0.15-35JD, but in WEPIA reported between JD 2.5-20.

6.2 Recommendations

In order to achieve the reduction of water consumption the usage of water saving devices is recommended because of its valuable amount of saving for both energy and water where 103915 KWh can be saved for 132 family /year, while 755 KWh could be saved for each family/year of the entire population of Al-Salt city and this is achieved if 100% of families use the water saving devices .in addition the amount of water that can be saved for 132 family /year 5364.7 m^3 and 592267 m^3/year for 17007 family of the entire population of Al-Salt city .

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APPENDICES

Appendix A

Questionnaire sheet about internal residential water uses

A-1 household internal residential water use questionnaire in Arabic language

اسم الحي :...............................

دخل الأسرة:

١)اقل من ٢٥٠   ٢) ٢٥٠-٣٥٠   ٣)٣٥١-٤٥٠   ٤)٤٥١- ٥٥٠
٥) اكثر من ذلك

طبيعة السكن :

١)بيت مستقل   ٢) شقه   ٣)طوابق

نوع البيت :

١) سكن (ا)   ٢) سكن (ب)   ٣) سكن (ج)   ٤) تطوير حضري

مساحه البيت.................................

مصدر المياه في المنزل:

١)سلطة المياه   ٢) بئر –مياه الأمطار فقط   ٣) صهاريج مياه خاصة
٤) بئر + سلطة

هل يوجد حديقه ؟

١)نعم   ٢) لا

مساحة الحديقة ....

اذكر عدد مرات الغسيل اسبوعياً ....

اذكر عدد دورات الغسيل لكل غسلة ....

عدد مرات غسيل السيارة اسبوعياً إن وجدت:

١) مرة واحدة   ٢) مرتين   ٣) أكثر من ذلك
طريقة غسل الملابس:

١) غسالة يدوية   ٢) غسالة اتوماتيك   ٣) على اليد   ٤) كل ما سبق

معدل الفاتورة الشهرية للربع (كم متر مكعب يستهلك من المياه)................

عدد أفراد العائلة ....

ضع اشارة صح (✓) في الفراغ لكل مرة استحمام خلال الأسبوع :

الفرد	العمر	معدل الاستحمام اليومي													
١															
٢															
٣															
٤															
٥															
٦															
٧															
٨															
٩															
١٠															

ضع اشاره(✓) في الفراغ لكل استخدام من استخدامات المياه خلال اليوم للعائله :

الاستخدام	معدل الاستخدام اليومي																						
غسل اليدين																							
تنظيف الاسنان																							
الوضوء																							
غسل الشعر																							

هل تعرف عن قطع توفير المياه؟

١) نعم ٢) لا

هل تفضل فكرة استخدام أدوات توفير المياه لترشيد الاستهلاك

١)نعم ٢) لا

إذا كان الجواب نعم اين تفضل استخدامها في داخل المنزل

١)المغاسل ٢) مجلى المطبخ ٣) دورة المياه ٤) الغسالة
٥) الشور

إذا كانت الاجابة لا................................ فهل ترفض ذلك لانك تعتقد :

١. انت غير متأكد من انها مجديه في توفير المياه

٢. يكلف ماديا دون اي نتائج ايجابيه

٣. احتمال حدوث تلف في القطع الصحيه المستخدمه في المغاسل والتواليت

ماذا تتوقع ان تكون سعر القطعه ....

ضع المتوقع توفيره من المياه كنسبة مئوية إذا استخدمت قطع توفير المياه ....

A-2 household internal residential water use questionnaire in English language

Region name ……………………………….

Family income

1)100-250 2) 260-350 3) 360-500 4) 510-650 5) above 650

Type of dwelling

1)Houses 2) flat 3)multistory

Area of residence…………………………………………………………………

The existence of garden

1)Yes 2) no

Class and category of residence area

1)A 2) B 3) C

Water source

1)water authority 2)well –rain only 3)water tanks 4)well and authority

The type of washing

1)Manual machine 2) automatic machine 3) manual washing 4)all mentioned

The number of washing cycles per week………………………………………

The number of car washing per week ………………….

Put (✓) in blank at each time of taking shower through week

Occupants	Age	Number of showering								
1										
2										
3										
4										
5										
6										
7										
8										

Frequency and type of sink use (hand washing, tooth brushing, ablution, hair washing

Categories	1	2	3	4	5	6	7	8	9	10
Hand washing										
Tooth brushing										
Ablution										
Hair washing										

The average cost of water bell for cycles…………………………………..

The number of occupants…………………………………………………..

Do u know about water saving devices?

1)Yes 2)no

Do you prefer using the water saving devices in house

1)Yes 2) no

If the answer is yes where you prefer use it inside your house:

1)sink

2)kitchen sink

3)water cycle (flushing ,showering ,….)

4)Laundry

If the answer is no …… do you refuse it because of:

1)you are not sure that it is not efficient for saving water

2)Costly without any beneficial effects

3)Possibility of damaging appliances

What do you expect its price ?

Fill the space in the percent you expected to be saved by using water saving devices …..

توزيع الاستخدامات الداخليه للمياه المنزليه في الاردن –دراسة حاله :مدينه السلط

اعداد

شيماء عبد الحميد خريسات

المشرف

الأستاذ الدكتورأحمد الجمره

ملخــــــــــــــص

الاستخدامات الداخليه للمياه المنزليه ذات اهميه كبيره بسبب بعض الظروف البيئيه مثل الانحباس الحراري وتزايد اعداد الناس ،ان معرفة استخدامات المياه ساعد الباحثون بتحديد طرق تخفيض الاستهلاك المنزلي للمياه بالاضافه الى اختيار طريقه مناسبه لمعالجتها.

لقد تم تحضير استبانه بشكل بحث اجتماعي خاص بمدينة السلط حيث تم الحصول على عدد ١٣٢ استبانه تم جمعها من عشرين حي سكني لمدة اسبوع ،هذه المعلومات التي تم جمعها حللت بطرق احصائيه متعدده وذلك لمعرفة الاستخدام الداخلي للمياه بالاضافه حساب نسبة المياه وكميه الطاقه اللتي يمكن توفيرها في حال استخدام قطع توفير المياه . كنتيجه فأن معدل الاستهلاك الفردي اليومي من المياه يساوي ١٠٣لتر /يوم.نسمه .بالاضافه لذلك فأن نسبة توزيع الاستخدامات الداخليه للمياه المنزليه لمعدل عائله مكونه من ٥ أشخاص هو ٢٠,٦٤% لاستخدامات المغسله ،٣٣,٨% للاستحمام ،١٠,٩١%للغسيل ،٤,١% لري الحدائق و٥% للطبخ و ٢٥,٥٦% للمياه العادمه .

قد تم اجراءاختبار الفرضيات للتأكد من أن معدل الاستهلاك الفردي للمياه الذي تم الحصول عليه هو في نسق واحد ومتوافق عند مستويات ثقه متعدده وهي ٩٠%،٩٥% و ٩٨% وكنتيجه لهذا الاختبار تبين ان جميع الاحياء يمكن اعتبارها حي واحد وعممت نتيجه العينه الممثله على كافة ارجاء المدينه حيث تحققت فريضة العدم .

٢٣,١ % هي نسبه توفير المياه في حال استخدام قطع توفير المياه ، فأن كميه المياه الممكن توفيرها سنويا في حال استخدام قطع توفير المياه ل ١٠٠% من العينه الممثله هو ٥٣٦٤.٧ دينار اردني ممكن توفيره سنويا وكذلك ٥٣٦٤,٧ م^{٣} بالاضافه الى معدل التوفير السنوي لكل عائله هو ٤١ م^{٣}. بالتالي ان كل عائله في المدينه من الممكن ان توفر من ١٩-٨٩ دينار اردني ثمن طاقه .

واخيرا لتخفيض الاستهلاك المياه بشكل جيد في المدينه فأن الدراسه توصي استخدام قطع توفير المياه بالمنازل لما لها من فائده كبيره في توفير المياه والطاقه .